The Blast Furnace and Steel Plant

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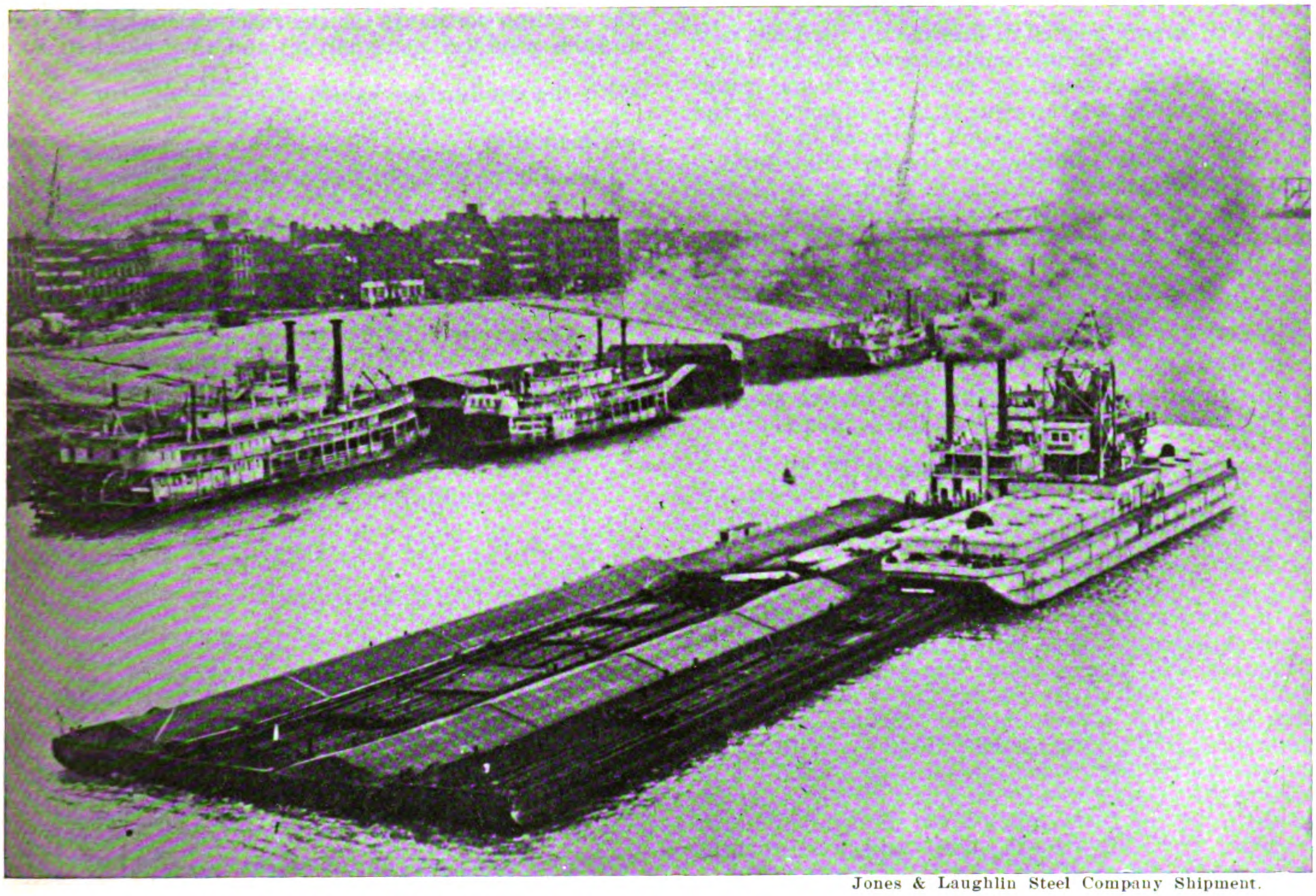
Commerce Coming Back to the Mississippi

Nation Wide Conference of Foreign Traders to Meet in New Orleans.



Jones & Laughlin Steel Company Shipment.

At the close of the Foreign Trade Convention, May 2-3-4, the new Inner Harbor-Navigation Canal at New Orleans will be formally opened. This canal connects the Mississippi River with Lake Pontchartrain, and transforms great tracts of interior lands into waterfront property, suitable for purposes of commerce and industry.

Commerce is coming back to the Mississippi and its tributaries.

The competition of the railroads that stripped the river of its old steamboats is rapidly being turned into co-operation even to the extent of through bills of lading, sharing of charges on through shipments, and such other mutual aids as are practiced among railroads. At such ports as New Orleans, where the $20,000,000 canal is to be opened, modern terminals will provide direct connection between river barges and railroads, as at Hamburg and Bremen, Germany's famous "free ports."

Electric cranes, moving platforms, trucks on skilfully built ramps, and all the other thousand and one modern devices for moving and handling freight, have been erected by the leading producers along the Monongahela, Ohio and Mississippi.

Last year the Barge Line handled 650,000 tons of freight, against a potential freight-carrying power of the river which is estimated at 150,000,000 tons a year. There are 55 barges in operation and 11 towboats.

The comparative development of waterways in the United States and Europe may be seen by these striking figures: The 650,000 tons carried by the Federal Barge Line represented just one-eightieth of the volume of commerce carried past the Netherlands-German frontier of the Rhine the last year before the World War.

The Production and Utilization of Producer Gas for Heating Open Hearth Furnaces*

From the Article Entitled, "Considerations sur la production et l'utilisation du gaz pauvre de gazogenes pour le chauffage des fours martin," by M. G. Husson, Rev. de L'Industrie Minerale 2-373-406 (1922).

PART I

CHAPTER I

THE customary method of determining the value of a gas by taking a sample, analyzing and calculating the heating value, assuming no hydrocarbons except CH_4, is insufficient. It neglects the influence of the water vapor, tar and fine carbon entrained in the gas. The chief objection, however, is the fact that the calorific power is taken at 32 deg. F. with air at 32 deg. F. and cooling the products to 32 deg. F. (low values for H_2 thruout) while the air and gas enter the furnace at about 1832 deg. F. and leave at at least 2912 deg. F. For this reason the value of the gas should be determined from the heat obtained by burning the gas at 1832 deg. F. with air at 1832 deg. F. and cooling the products to 2912 deg. F.

This heat recovered per cubic foot of wet gas, i.e., the heat utilizable above 2912 deg. F. is called L^1. The efficiency of the gas in the furnace is $P^1 = \frac{L^1 100}{M}$ where M is the heat in the quantity of fuel burned to give one cubic foot of gas. A study of the values of L^1 and P^1 is one of the first steps in studying the value of a gas.

Another even more important factor is the length of time a gas remains in the furnace. From a rough calculation this time is about one second. It is important to furnish a gas having the required heating value and with a maximum flame temperature and a minimum quantity of gaseous products. With a low temperature the heat transfer must be increased by increasing the velocity and so running the risk of having the gas leave the furnace before all the available heat is used. In other words, with any fixed hearth temperatures there is a velocity limit for a gas beyond which an increase in heat supplied means an almost equal increase in heat lost. The technical value of a gas is thus characterized by its theoretical temperature of combustion, T, deg. F. and the utilizable heat above 2910 deg. F. N per cubic foot of burned gas at T deg. F. From this it is seen that N equals the utilizable heat above 2912 deg. F. per cubic foot of flue gas at theoretical flame temperature. For each gas studied, L^1, P^1, T° and N, should be calculated, and the higher T° and N, the better the gas.

CHAPTER II

The assumption is made that the gas leaving a producer is in equilibrium with the coal, and the assumption is justified by the fact that LeChatelier calculated the reaction constants for the reaction $2CO = CO_2 + C$ from producer gas analyses and they checked well with the equilibrium values of $\frac{(CO)^2}{CO_2}$ determined experimentally.

On a basis of 1 mol * of producer gas, let

$C_1 = CO$
$C_2 = CO_2$
$C_3 = H_2$
$C_4 = H_2O$
$C_5 = N_2$
λ_1 = molal heat of perfect gases from 32° F. to t° F. in Btu. per pound mol.
λ_2 = molal heat of carbon dioxide (CO_2) from 32° F. to t° F. in Btu. per lb. mol.
λ_3 = molal heat of water vapor (H_2O) from 32° F. to t° F. in Btu. per lb. mol.

Then at equilibrium

$$\frac{C_1}{C_2} = K \quad (1) \qquad \text{and} \qquad \frac{C_2}{C_4} = K^1 \quad (2)$$

calling $N_2 = 4O_2$; from oxygen balance

$$\frac{C_1}{2} \pm C_2 = \frac{C_5}{4} + \frac{C_3}{2} \qquad (3)$$

and

$$C_1 + C_2 + C_3 + C_4 + C_5 = 1 \qquad (4)$$

and from a heat balance

$$\begin{aligned} C_4 + r = {} & 52{,}400\ C_1 + 175{,}000\ C_2 - 105{,}000 \\ & \lambda_1 (C_1 + C_3 + C_5) + \lambda_2 C_2 + (19400 + \lambda_4) \\ & C_3 + 21{,}100 (C_3 + C_4) \qquad (5) \end{aligned}$$

where r is heat lost by radiation.

Table I gives the values of K, K^1, λ_1, λ_2 and λ_4 for values of t° from 900° F. to 1800° F. Calculations of the effect of temperature are then made on the assumption, first, that r = O, and then r = 10% of the total heat in the coke.

TABLE I

t°C	t°F	K	K^1	λ_1	λ_2	λ_4
500	932	0.106	0.420	6,420	9,410	8,620
600	1112	0.940	2.300	7,760	11,600	10,570
700	1292	3.700	6.200	9,110	13,950	12,700
800	1472	11.100	13.600	10,490	16,330	14,800
900	1652	64.000	45.000	11,920	19,300	17,300
1000	1832	165.000	103.000	13,380	22,400	19,800

Translated and condensed by Prof. R. T. Haslam and Mr. H. O. Forrest, Department of Chemical Engineering, Mass. Institute of Technology, Cambridge, Mass.

*Where 1 mol. is 1 molecular weight of the gas in pounds and is equal to 359 cu. ft. at 32 deg. F. and 760 mm of mercury for all gases.

SAMPLE CALCULATION OF PRODUCER GAS COMPOSITION AND QUALITY

A sample calculation when temperature of gas from producer T = 1300° F. (700° C) when (from Table I) $K = 3.7$, $K^1 = 6.2$, $\lambda_1 = 9{,}110$, $\lambda_2 = 13{,}950$ and $\lambda_4 = 12{,}700$, is given below. The assumption is made that the heat loss (r) is 10% of the heat in the coke, or $[12 \text{ x } 14{,}500\ (C_1 + C_2) \times 0.10]$. This is approximately $18{,}000\ (C_1 + C_2)$.

In terms of C_5 the previous equations become:

$$C_2 = \frac{C_5\ (1 - K^1) + 2K^4}{4K\ K^1 + 6K^1 + 2K + 4} \qquad (6)$$

$$C_4 = \frac{2K + 4 - C_5\ (3K + 5)}{4K\ K^1 + 6K^1 + 2K + 4} \qquad (7)$$

$$C_1 = KC_2 \qquad C_3 = K^1 C_4 \quad (1) \text{ and } (2)$$

Solving these equations we get,

$$\begin{aligned} C_2 &= .0896 - .0376\ C_5 \\ C_1 &= .332 - .139\ C_5 \\ C_4 &= .0825 - .116\ C_5 \\ C_3 &= .512 - .719\ C_5 \end{aligned}$$

Substituting in equation (5) we get,

$$27{,}240 = 50{,}210\, C_5$$

Then

$$\begin{aligned} C_5 &= .542 = 54.2\% \\ C_1 &= .254 = 25.4\% \\ C_2 &= .069 = 6.9\% \\ C_4 &= .019 = 1.9\% \\ C_3 &= .120 = 12.0\% \end{aligned}$$

(Orsat Analysis)

Or on a dry basis as a gas analysis would show the producer gas composition as calculated for the temperature of 1300 deg. F. would be:

$$\begin{aligned} CO_2 &= 7.05\% \\ CO &= 26.0\% \\ N_2 &= 12.25\% \\ H_2 &= 12.25\% \end{aligned}$$

The calorific value of the gas per pound mol is then $123{,}000\ C_1 + 105{,}000\ C_3$ and per cubic foot it is

$$\frac{123{,}000\ C_1 + 105{,}000\ C_3}{359}$$

For the above gas the heating value L is 124 Btu. per cu. ft. The carbon in 1 cu. ft. of this dry gas is $\frac{.3305 \times 12}{359} = .01105$ lbs. Thus one pound of ash free coke gives $\frac{1}{.01105} = 90.5$ cubic feet of gas. The producer efficiency P, is then $\left(\frac{90.5 \times 124}{14{,}540}\right) 100 = 77\%$.

This same method of calculation was used for values of producer gas temperature T from 900 deg. F. to 1800 deg. F. assuming r = O and then r = 18000 $(C_1 + C_2)$. The values obtained when r = O gave results much higher than ever obtained in practice showing as would be expected that the assumption was far from the truth. For this reason the values are not given here.

The results obtained when the heat loss is 10% are shown in Table III and Fig. 2, where L = Btu. per cu. ft. of gas, V = cu. ft. of gas per lb. fuel and P = the producer efficiency. At 1650 deg. F. the values for $\%H_2$ and H_2O are slightly negative. There is therefore a temperature—very close to 1650 deg. F.—where equilibrium is obtained without injection of steam.

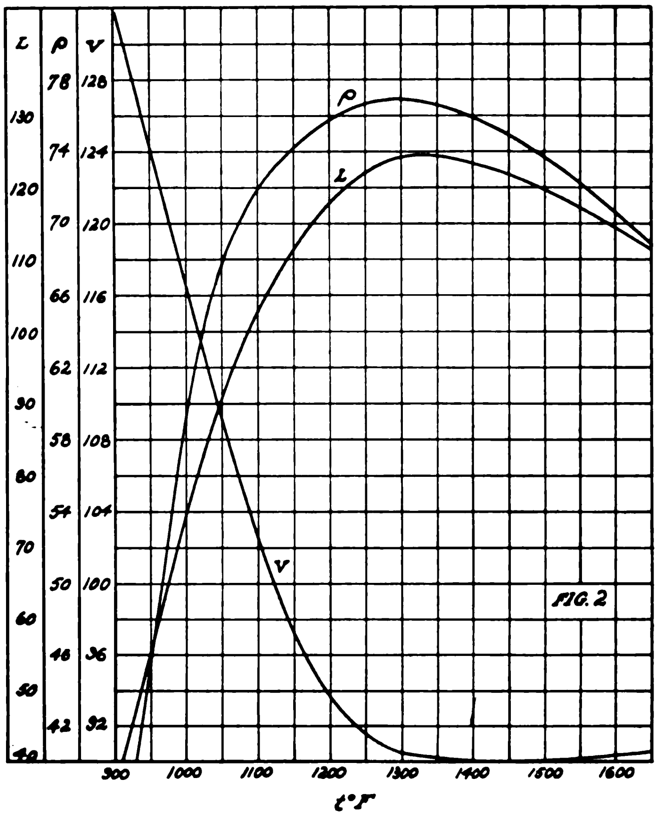


FIG. 2

FIG. 2—*Curves showing results at* 10 *per cent loss.*

The heat of combustion at 1832 deg. F., L_{1832}, is sufficiently close to the heat of combustion, L, at 32 deg. F., assuming the gases cooled to 1832 deg. F. after combustion. Therefore

$L^1 = L_{1832} - \lambda_{2912}$ ($\lambda 2912$ being the total heat from 1832 deg. to 2912 deg. F.)

While for O_2, N_2, H_2 $\lambda 2912$°F. = 9120 Btu.
and for CO_2 " = 19200 Btu.
and for H_2O " = 16800 Btu.

The volume after combustion is, however, $[2(C^1 + C_3) + C_5 \text{ mols } N_2] + [C_1 + C_2 \text{ mols } CO_2] + [C_3 + C_4 \text{ mols } H_2O]$.

TABLE III—GASES OBTAINED FROM COKE AT VARIOUS TEMPERATURES — HEAT LOSS = 10%

	Analysis of Wet Gas					Analysis of Dry Gas				L	V	P	
t°F.	CO_2	CO	H_2	H_2O	N_2	CO_2	CO	H_2	N_2	Btu. / Cu. Ft.	Cu. Ft.	No. C / Cu. Ft.	P
932	16.1	1.7	10.2	24.3	47.4	21.4	2.25	13.5	62.5	47.1	126.8	.00793	0.406
1112	14.0	13.2	17.7	7.7	47.2	15.2	14.3	19.2	51.1	105.0	101.0	.00998	0.726
1292	6.9	25.4	12.0	1.9	54.2	7.05	26.0	12.25	55.3	124.3	90.5	.0111	0.770
1472	2.75	30.5	5.5	0.4	61.0	2.76	30.6	5.5	61.2	121.	90.0	.0112	0.743
1652	0.5	32.5	0.0	0.0	67.0	0.5	32.5	0.0	67.0	111.2	90.5	.0111	0.688
1832						Impossible to obtain.							

Then per cubic foot of wet gas, the heat utilizable above 1932 deg. F. is

$$L^1 = \frac{1}{359}(85{,}400\ C_1 - 19{,}200\ C_2 - 69{,}600\ C_3 - 16{,}800\ C_4 - 9{,}120\ C_5)$$

Using this formula L^1 was calculated for producer gas made at various producer temperatures and values are given in Table IV. The efficiency of the gas in the furnace, P^1 is obtained by dividing L^1 by M. The value of T is determined by interpolation between intervals at 350 deg. F., assuming a straight line between the two temperatures. W is the volume of the products of combustion at 32 deg. F. and U at T deg. F., or $U = W\left(\frac{T + 460}{492}\right)$ and $N = \frac{L^1}{U}$.

Table IV contains the results of these calculations. From Fig. 3 it is seen that the utilizable heat above 2932 deg. F. (N) and the efficiency of the gas in the furnace P^1 pass through a maximum between 1300 deg. F. and 1470 deg. F. While P^1 passes through a maximum between their temperatures it should be noted that a hotter gas is of considerable value, but a colder gas is very much poorer.

In these calculations we have made the assumption that the heat loss is a constant fraction (10%) of the total heat in the coke.

CHAPTER III

The hypotheses on which this study of the gasification of an average gas coal is based, are:

(1) That a well operated gas producer can be considered to be a coke gas producer, with the gas leaving the producer in equilibrium with coke and a thin layer of coal which distills and cokes in the same manner as in coke ovens.

(2) That the heat given off in coking can be neglected since it amounts to only about 450 Btu. per pound of coal.

In other words, the thin bed of coal, thermally neutral, does not affect the equilibrium conditions. The fact that the uncoked coal bed is thin was shown when coke, containing only 1 per cent volatile, was found on the distributer of a producer shut down for a short time. The temperature in the producer is high enough so that the coking takes place very quickly.

There are three things which prevent the gas reaching equilibrium with the coke. They are, (1) channeling; (2) too high an air velocity with a thin fuel bed: (3) too thick a fuel bed so that the top is cold. However, tho the producer gas obtained in practice is not, in general, in equilibrium, it is still true that the gas that would be produced at equilibrium is the ideal gas and represents the limiting conditions beyond which we cannot go.

Consider a coal of the following analysis, on an ash free basis:

C	85.0%
H_2	5.5%
O_2	8.5%
N_2	1.0%
Btu. per lb.	15,480
Vol. matter	33 %
Fixed Carbon	67 %
Volatile Carbon (85.0 — 67.0)	18 %

The distillation of 1,000 lbs. of this coal will give, according to the classification of M. Emile Sainte-Claire Deville; about 4,800 cu. ft. of gas of the following composition:

CH_4	33%
H_1	53%
CO	7%
CO_2	1.5%

Total non-condensable products 4540 cu. ft.

The gas contains 60 lbs. or 1,190 cu. ft. of H_2O vapor or a total volume of wet gas equal to 5730 cu. ft.

The weight of components in the non-condensable volatile matter is 67 lbs. carbon, 39 lbs. hydrogen, and 75 lbs. oxygen. Assuming the N_2 forms NH_3, using 10 x 3/14 lbs. of hydrogen, we have left in the condensable portion of the volatile matter, 113 lbs. C, 14 lbs. H_2 and 10 lbs. O_2 per 1,000 lbs. coal.

According to LeChatelier, experience shows that if the producer gas leaves much below 1472 deg. F. the tars are not decomposed but condense along the mains. On the other hand, if the gas is much above 1472 deg. F. the tar decomposes completely and the soot chokes the flues more rapidly than the tar itself.

The optimum temperature using coke was found in Chapter II to be between 1292 deg. F. and 1472 deg. F. The most favorable temperature for distillation is about 1292 deg. F. since below this temperature the distillation is too slow and the tars cement the coke together too closely causing caking. In other words, from the point of view of both zones, a temperature of 1292 deg. F. to 1472 deg. F. is the best for a coal gas producer.

Calculations are made for a temperature of 1292 deg. F. assuming r = O and $r = 18{,}000\ (C_1 + C_2)$. (Approximately 10 per cent of the heat in the coal.) Further calculations are made with t = 1472 deg F. when $r = 18{,}000\ (C_1 + C_2)$, in one case assuming no dissociation of tar and in the other that the tar is entirely dissociated. The results show that the assumption of r = O is impossible and that $r = 18{,}000\ (C_1 + C_2)$ is reasonable. Also, the true value at 1472 deg. F. must be between the two values calculated on these assumptions.

The composition of the gas is determined by adding together the products from the coke zone and the distillation zone. The results are given in Table V.

TABLE IV—CHARACTERISTICS OF GASES FROM COKE AT VARIOUS TEMPERATURES

t°F	L^1 Btu. ft.^{3}	$P^1 = L^1 \div M$	L Btu. ft.^{3} wet gas	$W^1 \div$ ft.^{3} / ft.^{3}	T°F.	U ft.^{3}	$N = L^1 \div U$
932	0	0	35.6	1,240	2723	8.05	0
1112	42.5	32.3	96.8	1,620	3668	13.6	3.11
1292	64.9	41.5	118.5	1,748	3992	15.85	4.10
1472	65.6	40.5	120.6	1,720	4055	15.80	4.15
1652	59.7	37.2	111.3	1,648	4051	15.1	3.95

TABLE V

	Temp. 1292° F.		Temp. 1472° F. 10% Loss of Heat by Radiation	
	No loss by Radiation	10% loss of Heat by Radiation	Tar Dissociated	Tar not Dissociated
%CO_2	7.2	6.45	2.50	2.60
%CO	26.7	23.80	27.30	28.30
%H_2	25.5	14.80	11.85	8.85
%CH	2.7	2.36	2.32	2.40
%H_2O	..	3.53	2.43	2.18
%N_2	..	49.06	53.60	55.80
Btu. per cu. ft.	191	147.5	145.2	150.0
Cu. ft. per lb. of coal......	59.9	67.4	66.2	68.7

In estimating the per cents of the various gases in the producer, no account has been taken of the tar. This should be considered as decomposed in the checkers so that the producer gas carries into the furnace some carbon, hydrogen and water vapor from this decomposition. The carbon is probably not deposited since it is fine and the velocity high, and very seldom is CO found in the exit gas from the checkers after reversals. At the top of the checkers then per pound of coal the gas contains 0.113 lbs. C, 0.014 lbs. H_2 and 0.010 lbs. O_2 from the tar. Using the 1292 deg. F. producer gas, the calorific power is

$$67.4 \times 147.5 + .113 \times 14{,}540 + \left(.014 - \frac{.010}{8}\right)$$

(52,000) = 12,250 Btu. per lb. of coal used, and not merely 67.4 × 147.5 = 9,940 Btu. In the case where the tar was decomposed in the producer (1472 deg. F.), the carbon was assumed to be deposited along the mains.

From the data of Table V with the addition of the decomposition products of the tar, Table VI was calculated, where $r = 18{,}000\ (C_1 + C_2)$ (approximately 10 per cent heat loss) in each case. The calorific value of the coal was 15,450 Btu. per pound on a moisture and ash free basis.

TABLE VI

	Temp. 1292°F.	Temp. 1472°F. Tar not Dissociated	Tar Dissociated
Btu. per lb. (L^1)........	7090	7070	5900
Eff. of gas in furnace (P^1)	45.8%	45.7%	38.3%
Theoretical Flame Temperature (T)	4190°F	4235°F	4155°F
Utilizable heat above 2912°F. per cu. ft. of flue gas at flame temp. (N)	4.71 Btu.	4.77 Btu.	4.51 Btu

The second gas is better and the third worse than the first, as shown by the values of P^1, T and N. However, the actual gas obtained at 1472 deg. F. will be nearly like that at 1292 deg. F. since in the first case some of the carbon will be lost in the checkers, and in the second not all of the carbon will be deposited in the mains.

The assumption has been made in the preceding discussion that the gas goes to the furnace hot so that none of the tar is deposited on the way, but no account has been taken of the sensible heat in the gas. The reason for this is that the sensible heat is of no interest because there is plenty of heat in the waste gases to supply any lack in the producer gas so that the sensible heat of the producer gas can be considered useless. For this reason it is advisable to inject steam to convert some of the sensible heat into latent heat even though steam would not be necessary to prevent clinker.

The amount of air and water necessary for the gassification of the coal may be readily calculated. For this calculation the previous calculation at 1292 deg. F. and 1472 deg. F. were used. The air necessary is (0.675 F.) cubic feet and the steam is (0.0050 F.) lbs. per lb. of coal, where F is the per cent fixed carbon.

CHAPTER IV

Influence of Producer Operation

If the mains leading to the furnaces are too cold the condensable products will be lost and the values of P^1 T, N will drop from 45.8 per cent, 4190 deg. F., 4.71 Btu. to 33.7 per cent, 4085 deg. F. and 4.43 Btu. respectively. Under these conditions the values of N and T are between those for coke and coal while P^1 is less than for coke, so that the gas is poor, even though ordinary methods of producer gas analysis would not show it.

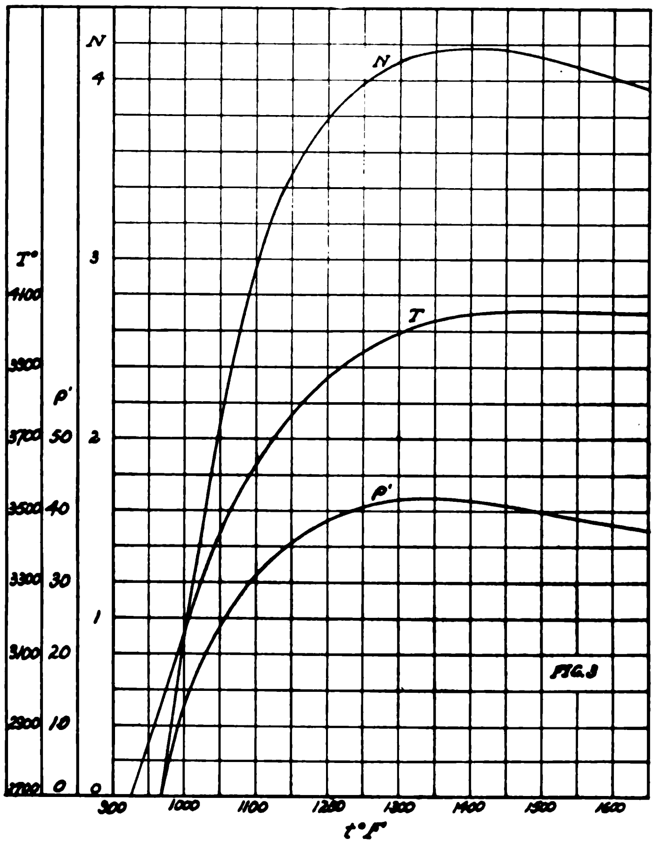


FIG. 3—*Utilizable heat above 2932 deg.*

If the producer is too cold the volatile matter will break up before distilling, caking the coke together as happens in the coke oven. Operators say that the cold producer becomes "choked." On the basis that a coal of the type used gives 70 per cent coke, calculations are made for 1112 deg. F. The results are:

ANALYSIS

CO_2	13.1%
CO	12.8%
H_2	19.6%
CH_4	1.9%
H_2O	8.6%
N_2	43.8%

QUALITY

Btu. per cu. ft.	119.5
Cu. ft. per lb. coal	82.3
Heat utilizable above 2912°F. (L^1)	6,050
Eff. in furnace (P^1)	39.8%
Theo. Flame Temp. °F. (T)	3910
N, available heat above 2912°F. per cu. ft. at flame temp. (N)	3.98 Btu.

The values of P^1, T and N are all considerably less than for a good gas from coke so that the gas is poorer although the calorific power is satisfactory.

If the producer is operated too hot, the tar is entirely decomposed, the carbon is deposited and the conduits and the calculations at 1652 deg. F. give

ANALYSIS OF GAS

CO_2	54%
CO	29.10%
H_2	2.05%
H_2	7.05%
CH_4	2.31%
N_2	59.00%

QUALITY OF GAS

Eff. in furnace (P^1)	35.8%
Btu. per cu. ft.	142.1
Cu. ft. per lb. of coal	69.0
But. per lb. (L^1)	5530
Theoretical Flame Temperature	4135°F
N, Utilizable heat above 2912 °F. per cu. ft. of flue gas at flame temp.	4.42 Btu.

The value of P^1 is less than with coke and even less than with a cold gas. The value of T is comparable with that of a producer operated at 1300 deg. F. to 1500 deg. F. and the value of N lies between that of coke producer gas and a standard coal producer gas.

CHAPTER V

Influence of the Kind of Coal Used.

Calculations are made for, (1) a long flame lean coal (low calorific power), and (2) for a short flame rich coal (hgh cialorific power), and (3), for a coal with high moisture content.

The analyses of these coals on an ash free basis are as follows:

	1	2	3
C	82.0%	87.7%	85.0%
H	5.6%	4.8%	5.5%
O_2	11.0%	6.4%	8.5%
N_2	1.0%	1.0%	1.0%
Vol. matter	37.5%	21.75%	30%
Fixed carbon	62.5%	78.25%	60%
Water	....	......	10%
Btu. per lb.	14.730	15,550	....

Knowing the class of coal the amount and composition of the distillation products are determined. The results of the calculations at 1300 deg. F. give producer gases of the following analysis and quality:

ANALYSIS

Coal No.	1.	2.
CO_2	0.3%	6.5%
CO	23.6%	24.1%
H_2	14.6%	14.2%
CH_4	2.5%	1.8%
N_2	48.8%	50.5%
H_2O	4.2%	2.9%
Btu. per cu. ft.	147.5	142.0
Cu. ft. per lb. coal	64.1	86.5

QUALITY

P^1	46.5%	47.5%	45.4%	45.8%
T (Flame Temp. °F.)	4180	4115	4155	4190
N_2	4.69	4.48	4.61	4.71

(Heat utilizable above 2910°F. per cu. ft. of flue gas at flame temperature.)

The values of P^1, T and N for the high volatile coal are very close to the others. In other words this theory does not show any superiority in a high volatile coal and the explanation must be founded on practical reasons. For the lower volatile coal the value of P^1 is higher, while N and T which show the characteristics of the gas more than does P^1, are lower than for the other two coals. In the case of the wet coal again, the values are close to those for the same coal dry, so that the reasons for the superiority of a dry coal must be practical ones.

(To be continued)

DR. HARKINS AT TECH

Remarkable photographs of high speed collisions of the nuclei of atoms obtained by the use of moving picture machine were shown by Dr. William Draper Harkins. of Chicago University. in a series of lectures April 16. 17, and 18, at Carnegie Institute of Technology, Pittsburgh. A new discovery by use of the photos was that the helium nucleus, used as a projectile, rebounds in a backward direction while the nucleus of the nitrogen atom which is hit is projected forward; both at speeds of several thousand miles per second.

Dr. Harkins, who discussed the general subject of "Isotopes, and the Building and Disintegration of Atom" spoke before representative audiences of Pittsburgh scientists, at each lecture. He traced the deveolpment of the atomic theory from its purely speculative beginning in the minds of the ancient philosophers to its present status as an experimentally demonstrated fact. Evidence was shown that each individual atom is a very complex body which may be likened to a minute solar system whose constituent parts may attain a velocity of many thousand miles per second.

In describing the discovery of radioactivity and of radium, he showed how these discoveries have enabled scientists to draw an accurate picture of the atom with its central "sine" or positively charged nucleus and its attendant "planets," or charges of negative electricity, called electrons. Dr. Harkins further developed the theory that the complex atoms are built largely from atoms of helim, which may be regarded as the atomic building blocks, capable of being assembled into various structures.

"Trade does follow the investment," Director Klein of the Bureau of Foreign Commerce declared, pointing out that the truth of this axiom is illustrated by the heavy export of American machinery to Chile, Peru and Bolivia where American companies are in operation. Dr. Klein said that in forecasting our Latin American trade the importance of these financial transactions must be given special consideration for they now amount to from $2,500,000,000 to $3,000,000,000. After the armistice, as a natural consequence of its newly acquired position as a creditor nation, the United States took the place of Great Britain, France and other European countries as the chief market for Latin American loans. These flotations reached their height in the first half of last year when a total of about $150,000,000 was issued.

Recently Rebuilt Blast Furnace Lorain No. 4 National Tube Company

No. 4 Furnace at Lorain Embodies Many Changes and Improvements Which Insure a Better Average Operating Condition and Increased Tonnage—Provisions Made for Future Enlargements.

TAKING advantage of the lull in furnace activities the early part of 1922, the National Tube Company completely rebuilt, redesigned and enlarged the No. 4 stack at Lorain, Ohio.

Originally this furnace was blown in in 1904, with a hearth diameter large for that period. However 17 ft. 4 in. has long since passed as a permissable width for large furnaces, and the present hearth diameter of 20 ft. 9 in., while the greatest now in service among eastern furnaces, may be further increased to 22 ft. 0 in. at some future relining period. Provision for this extension has been allowed for in the new design.

A number of highly important changes and improvements have been incorporated.

The plate thickness for the furnace shell has been made heavier. Seven-eights in. steel plates being used for the furnace shell proper, with 1⅛ in. thick plates for the mantel ring.

The insistent demands of improved working furnaces, for adequate stock distribution have resulted in a special McKee top, designed, however, by National Tube engineers.

The essential features embodied in the design provide for a suitable sized and shaped receiving hopper,

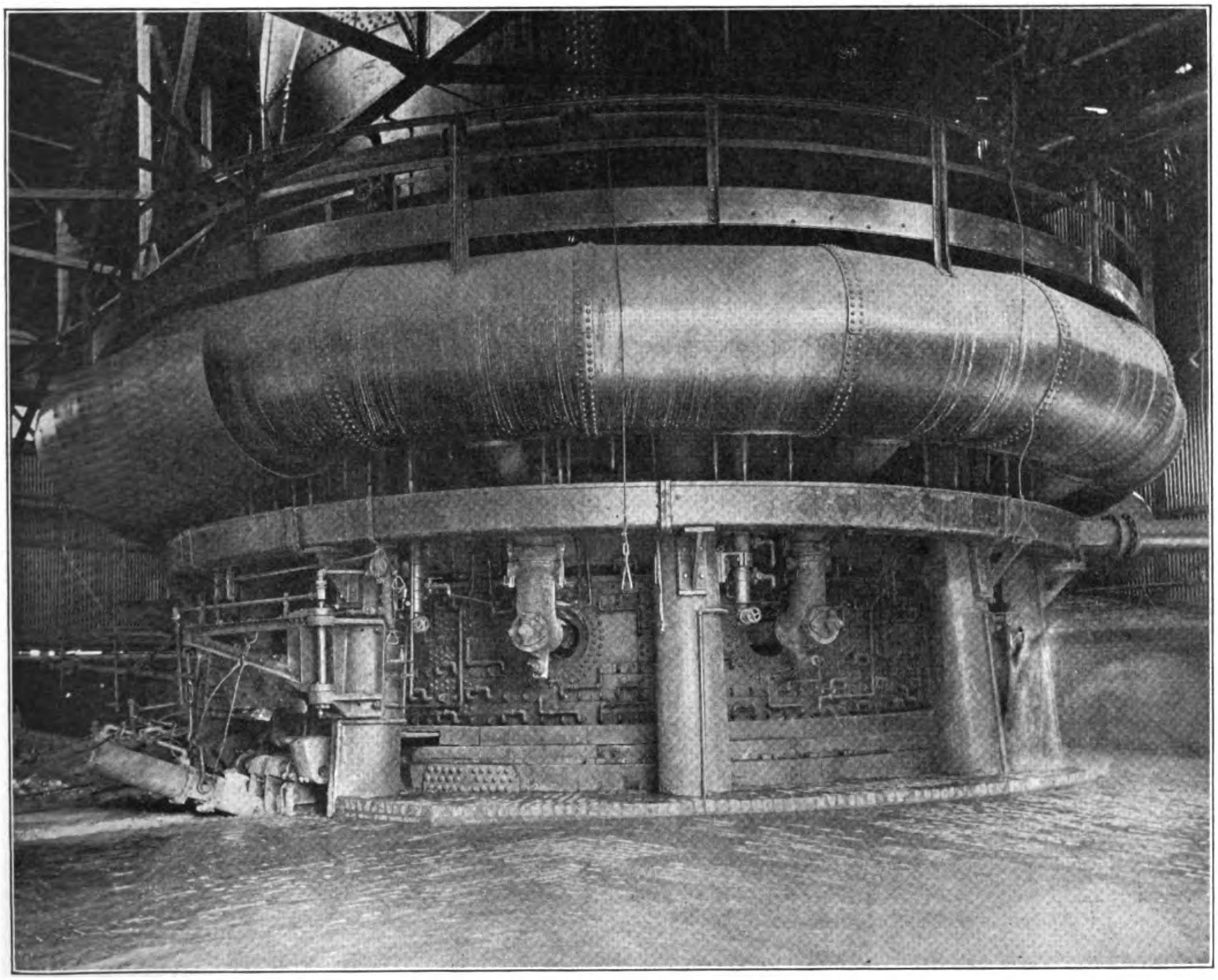


FIG. 1—*Bottom of Lorain furnace, showing large bustle pipe.*

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and an accurately correct dumping position of the skip, so that all stock materials are distributed equally on the large bell, while at the same time scattering the lumps and fines so that no part of the complete circle shows a predominance of either.

The stock drops from the small bell into the box which is divided into four quadrants by partitions, each tapering at the top edge to a knife edge. The partitions cut the box diagonally thus making one quadrant on skip-side, one on front side, and one on each of the other two sides.

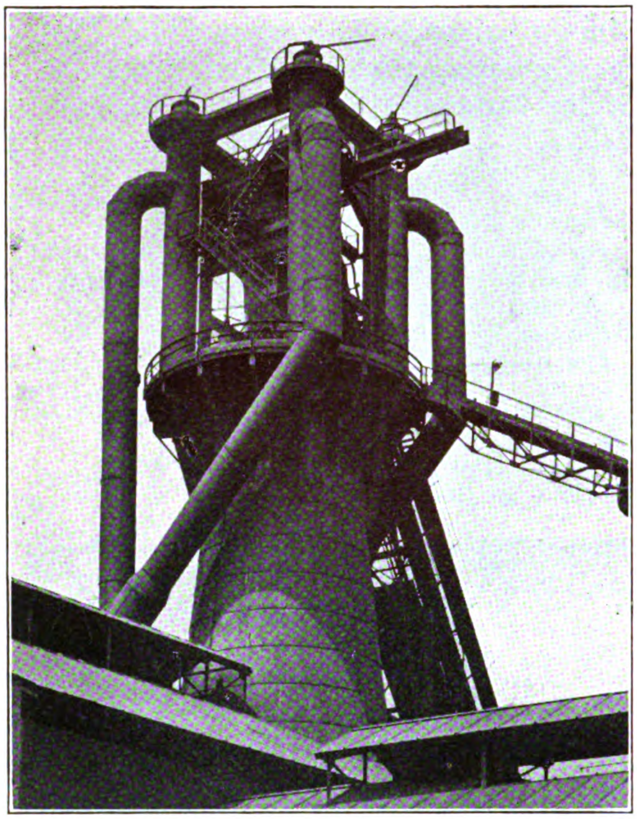

FIG. 2—*Furnace top with valves.*

Fig. 1 reflects the thoroughness of the bottom construction.

The large bustle pipe made of horn-welded pipe with butt strap radial and circular seams 61 in. inside diameter with a 9-in. lining; 10 tuyeres, with seven rows of cooling plates, 30 in each row, above the tuyeres.

Fig. 2 clearly shows the down-comers, with the four Baer Bleeder Valves at top.

The four two-pass Cowper type stoves 21 ft. diameter x approximately 100 ft. height are equipped with highly efficient Steinbart Stove Burners.

Fig. 3 shows a cross section of the furnace, with excellent details of the distributing top design.

Fig. 4 gives a cross section of a typical stove, with details of checker openings. and refractories used.

Harbison Walker fire brick were used throughout, there being 600,000 bricks in the furnace lining, while the equivalent to 9 in. brick in each stove checker work totals 139,000.

Morrison & Kennedy chimney valves were installed.

The dust catcher has an auxiliary hopper; the gas passes to the outside, and expands in the upper chamber, the enlarged volume and reduced velocity resulting in dust deposit.

The present piping re-arrangement has effected a 50 per cent cooling water reduction.

A summary of the specifications covering both the furnace proper and the stoves follows:

Furnace height	90 ft. 6 in.
Hearth diameter	20 ft. 9 in.
Bosh diameter	23 ft. 6 in.
Bell diameter	13 ft. 0 in.
Bosh angle	82 deg.
Thickness of shell	⅞ in.
Thickness of bottom ring	1⅛ in.
Diameter of dust catcher	27 in. x 36 ft. high
Diameter of bastle pipe	61 ft.

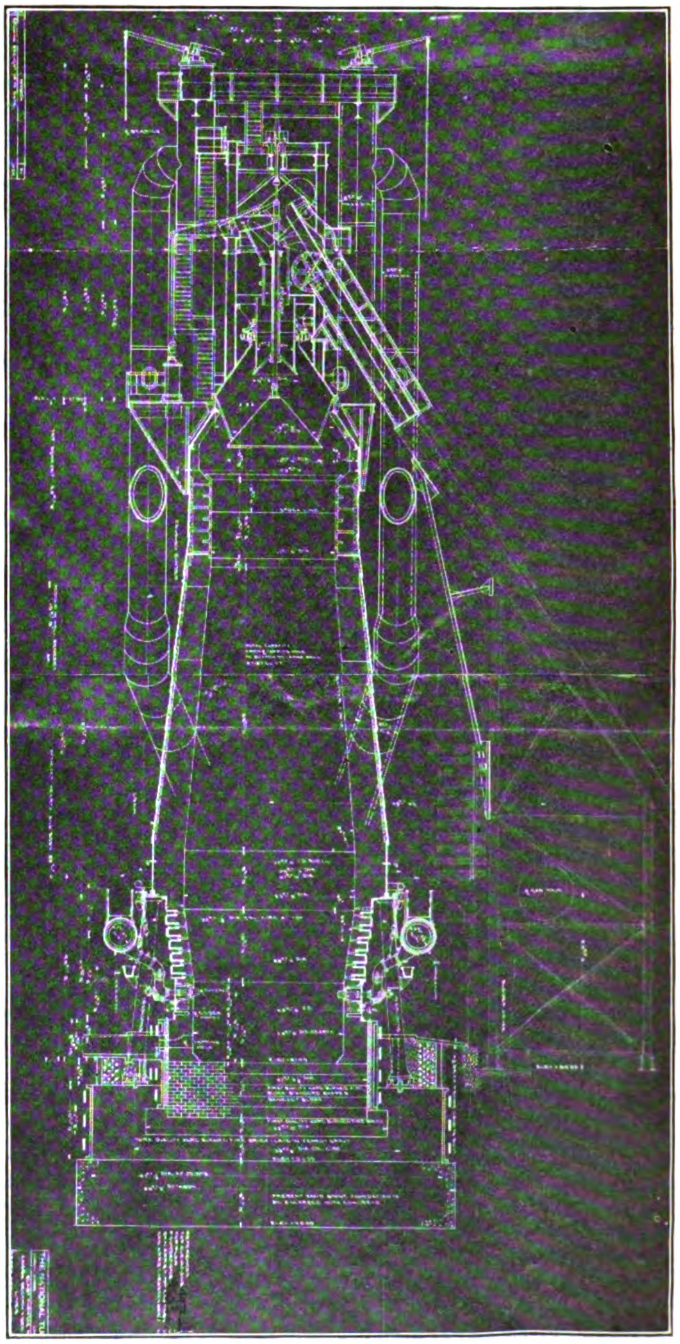

FIG. 3—*Cross section of new furnace.*

Volume of furnace	27,372 cu. ft.
Capacity of skip cars	150 cu. ft.
Construction of hearth jacket steel castings, banded size of bottom block	18 in x 9 in x 6 in.

Double skip hoist.
Steam operated bell.
Hoist engine No. 2 Otis, with 200 hp. motor.

STOVES

Diameter of combustion chamber inside skin wall	6 ft. 0 in.
Number of checker openings	508
Area of checker openings	71.44 sq. ft.
Area of checker openings	10,287 sq. in.

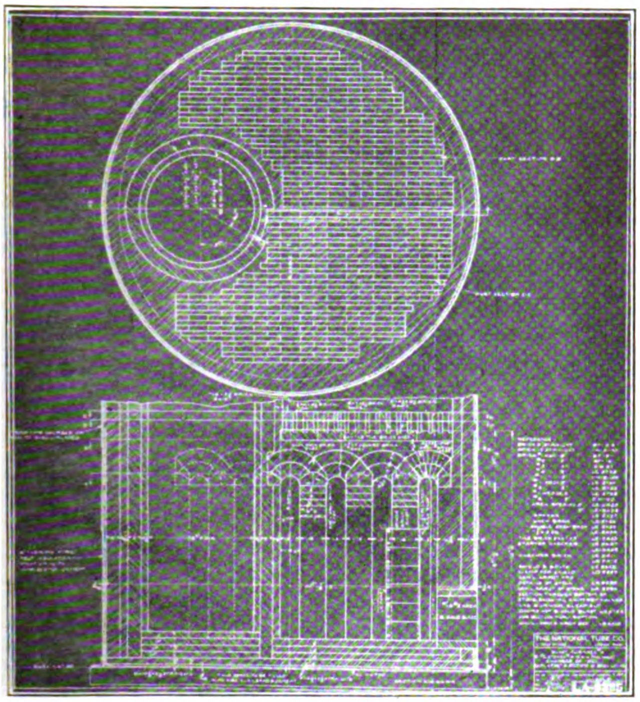

FIG. 4—*Detail of modern stoves.*

Area of two chimney valves, 36 in. dia.	2,036 sq. in.
Area of openings into bottom chamber	6,639 sq. in.
Area of combustion chamber	35,785 sq. ft.
Volume of gas cooled from 2,000 deg. F. to 300 deg. F.	1 to 0.2233
Area of heating surface (including top surface)	56,688 sq. ft.
Area of heating surface per foot of height of checkers	762 sq. ft.
Size of checker brick in regular course	7 in. x 6 in. x 2½ in. x 11½ in. x 6 in. x 2½ in.
Size of checker brick in joint course	9 in. x 7 in. x 2½ in. x 11½ in. x 9 in. x 2½ in.
Number of checker brick in each course	68 and 507 resp.
Number of 9-in. brick equivalent to checkers	139,000
Height of stove	99 ft. 6⅝ in.
Ratio of area of checker openings to area of combustion chamber	1,996 to 1
Weight of shell, bottom and dome	162,100 lbs.
Weight of checkers	976,200 lbs.
Load on brick piers supporting checkers	14 tons per sq. ft.
Load on brick piers supporting checkers	195 lbs. per sq. in.
Diameter of stoves	21 ft. 0 in.

INSPECTION TRIP

On Friday, April 20th, the Philadelphia section of the Association of Iron and Steel Electrical Engineers were the guests of the Bethlehem Steel Company for an inspection trip through the Bethlehem Steel Plant. Both the Lehigh and Saucon plants were inspected under the chief guidance of Mr. A. J. Standing, electrical superintendent of the Lehigh plant, and Mr. D. M. Petty, electrical superintendent of the Saucon plant, both Past Presidents of the Association.

The inspection trip was divided into two sessions, morning and afternoon. Between the two sessions, luncheon was served to about 150 visiting members of the association in the main dining room of the Bethlehem Steel Works. At the dinner short speeches were heard from the president and secretary of the association, Mr. Charles A. Menk of Homestead Steel Works, formerly president of the association; Mr. John F. Kelly, now secretary of the Pittsbugh section, and Mr. Roy A. Lewis, general superintendent of the Bethlehem Steel Company. Following the afternoon trip through the Lehigh plant, dinner was served at the New Bethlehem Hotel.

The Lehigh plant has seven blast furnaces, 16 blowing engines, 87 water tube boilers, by-product coke ovens, 16 open hearth furnaces, two 400-ton hot metal mixers, three electric furnaces, 17 rolling mills (rolling blooms, billets, bars, muck and iron bars), 60 bar, bloom heat treating and projectile heating furnaces, 138 shell heating furnaces, 48 box annealing furnaces, 57 steam and board hammers (some as high as 16000 pounds), 44 hydraulic forging presses and many other interesting items too numerous to mention, but well worth seeing.

The Saucon plant at Bethlehem was built in 1906-07. First steel was made August 12, 1907; first rails rolled August 31, 1907; first structural shapes June 8, 1908. This plant has 10 50-ton, six 75-ton (stationary) and two 200-ton tilting basic open hearth furnaces, making a total of 18. It has three 20-ton Bessemer converters for duplexing, four metal mixers, three cupolas; annual capacity about 1,000,000 tons basic open hearth ingots. There is also a 46-in. two-high stand bloomer, 48-in. two-high stand intermediate and a 48-in. two-high stand finishing structural for wide flange beams; a 42-in. Bethlehem shape mill; a 40-in. blooming mill; a 28-in. rail mill, with one stand two-high roughing and a one stand three-high and a one stand two-high finishing; a 28-in. structural mill and a 28-in. and 16-in. finishing mill.

The figures quoted in the description of both plants are approximated, but we believe they will serve the purpose for which they are intended.

Among the most interesting new developments at Bethlehem were the production of steel auto wheels from standard I-beam sections, described in *Forging and Heat Treating,* April, 1922, and the casting, machining and assembly of the sections for the Hudson Vehicular Tunnel; this latter was described and illustrated in an article in *Iron Trade Review,* April 19 issue.

The electrical superintendents of the Bethlehem plants are all members of the A. I. & S. E. E., among them being Mr. R. B. Gerhardt, of the Sparrows Point Plant, who is also president of the A. I. & S. E. E.; Mr. J. R. Reed, of the Steelton plant; T. E. Tynes, of the Lackawanna plant; Charles Proudfoot, of the Cambria plant, and Harry Holles, of the Lebanon plant.

Design and Construction of Electric Furnaces

Comparative Sizes of Various Types—Many Combinations Possible for the Various Specification Demands—Practical Wiring Diagrams.

By LARRY P. BARTON*

SINCE the acceptance of the electric steel furnace in modern metallurgy, there has been a gradual increase in the number of different furnaces placed on the market. In this country the Heroult furnace pioneered the way, and later furnaces have been developed along the general lines laid down by this design. In late years there have been several furnaces placed on the market embodying a rather new principle, that of inductive heating, but as these are in the great minority as regards commercial operations, they will be neglected in this paper, which will cover the more common type of arc furnace.

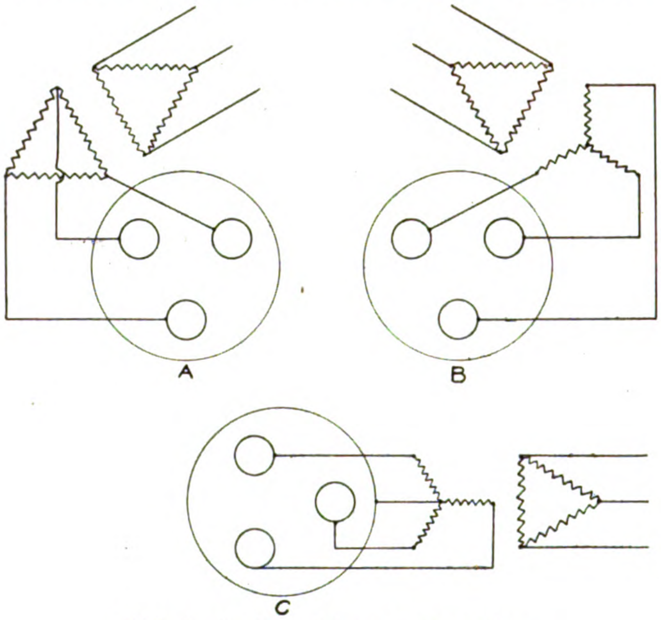

FIG. 1—*Design of furnace connections.*

In the design of an electric furnace there are many points to consider. These are outlined as follows:

1—Electrical
- (a) Transformers and high line equipment.
- (b) Leads, power factor, etc.
- (c) Different electrical connections.
- (d) The question of bottom electrodes.
- (e) Electrodes.
- (f) Regulators.

2—Metallurgical
- (a) Hearth.
- (b) Walls.
- (c) Roof.
- (d) Doors.
- (e) Electrode arrangement.
- (f) Shape of furnace.

3—Mechanical
- (a) Tilting method.
- (b) Electrode holders.
- (c) Cooling rings, or electrode economizers.
- (d) General cooling arrangements.
- (e) Charging of furnace.

In the practical working out of the above points there are, of course, many different combinations available, each of which will satisfy the required conditions. These different methods of handling are embodied in the different electric furnaces of today, each having some slight point in variance from its fellows. Opinions regarding the superiority of some of these features are vastly different, and while the features of some furnaces may be neglected in this short article, it is hoped that no forgotten manufacturer will take offense, as this paper is not intended to show the best furnace on the market, but merely to use modern types as an illustration of fundamental principles. In this connection it might be well to reiterate what I have often said, that it is not the furnace itself which means success or failure, but the ability of the operator.

1—Electrical.
- (a) Transformers, and high line equipment.

This is the starting point in the installation, and there are several points to here consider. Common practice has shown that in actual operation of steel furnaces it will take approximately 600 to 650 kwh. of power to melt and refine one ton of soft steel, depending on the size of furnace, and the operating conditions. In choosing the transformer the voltage desired in the furnace itself must be considered, together with the above power input. This will cover the actual size of the transformer needed if all conditions were perfect. This is impossible as during the melting down there will be constant surges and overload, which must be considered. Then, too, there is the question of power factor, which increases the size of transformer needed. These questions have been carefully worked out by the different manufacturers of transformers so often that it is now standard, and the transformers can be purchased to cover any size of installation, the line and furnace voltages being given.

On the market at the present time there are two main types of transformer illustrated by the Heroult and the Pittsburgh. The Heroult furnace operates at a voltage close to 110, and the transformers have a capacity of close to 250 kva. per ton of furnace capacity. The Pittsburgh or 'Lectromelt operates with a corresponding voltage of nearly twice the above, and the transformer is proportionally large.

Such equipment as oil switches, etc., is so standard that little need be said about it here. All of the large electric manufacturing companies specialize on this class of work for electric furnaces, and there are many different designs.

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*Consulting Engineer, San Francisco, Cal.

(b) Leads, power factor, etc.

With the furnace power input decided it becomes an easy matter to calculate the amount of copper required to carry the load. It should be here remembered that the closer the furnace is to the transformer, the better will be the power factor. It is, therefore, imperative to make these furnace leads as short as possible, a point which has only lately been paid the necessary attention.

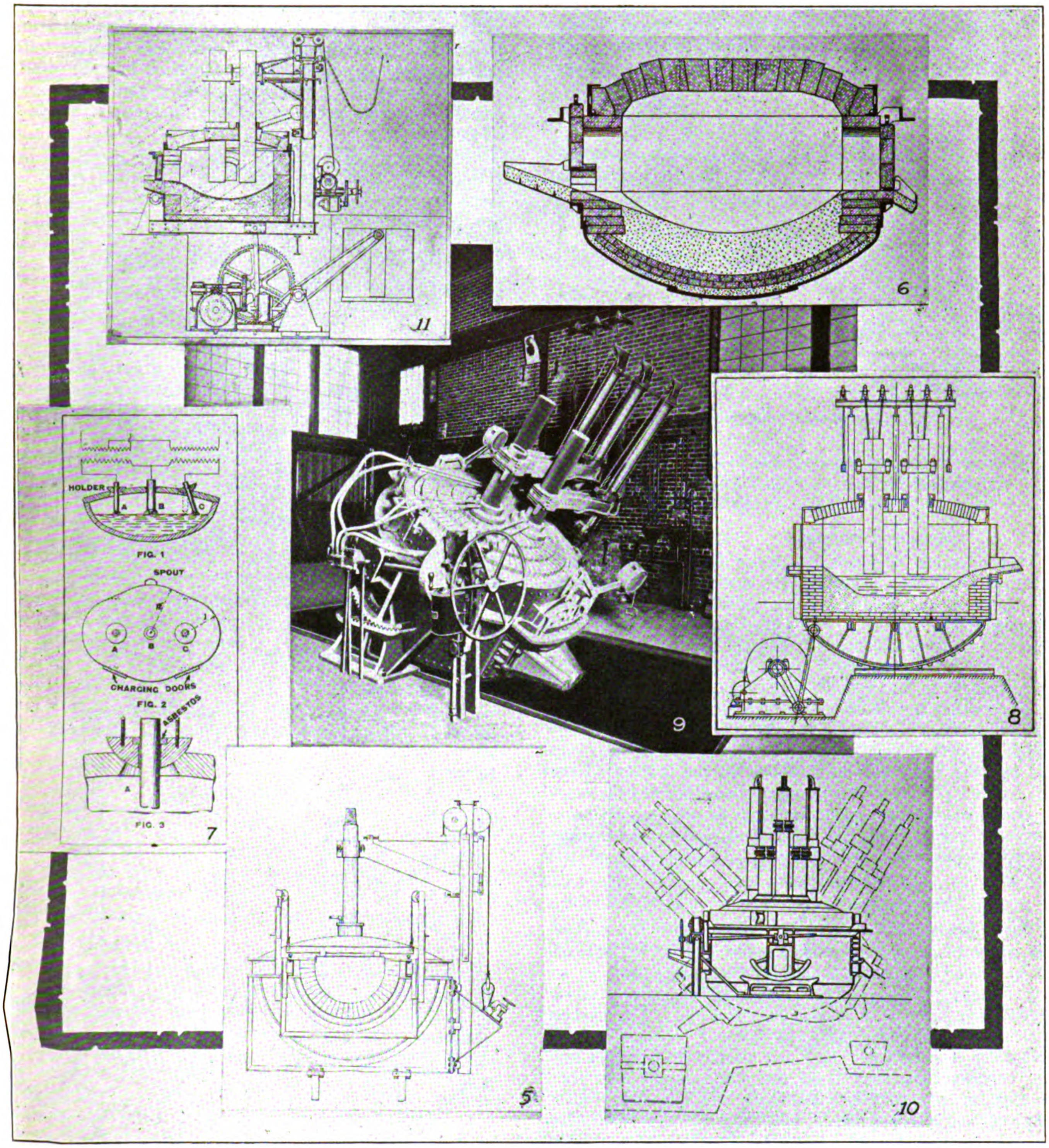

FIG. 2—*Cross sections and views of various electric furnaces.*

From the transformer the leads are usually heavy copper bus bars, which connect to flexible cables. These cables take care of the movement of the furnace during the pour, slagging off, etc. One of the best ideas I have ever seen on the question of short leads was at the shop of a prominent eastern steel firm. Here instead of having cables to take care of the furnace tilt, there was a system of interlocking bus bars. As soon as the furnace was tilted these would come apart, and when back in normal position would slide back into place. This eliminated about 10 feet of lead cable with its attendant increase in power factor. The only objection to this method was that it would be impossible to tilt the furnace with the power on, which sometimes is necessary, but I believe the increased power factor obtained would more than make up for this slightly undesirable point.

(c) Different electrical connections.

Electrical connections, or methods of transformer wiring, show wide variances on the different furnaces. Connections run on two, three, and four phase, with many combinations. The majority of installations are run on three phase connections, due to the fact that nearly all power companies are on this combination. Figs. 1, 3 and 4 show some present day furnace connections.

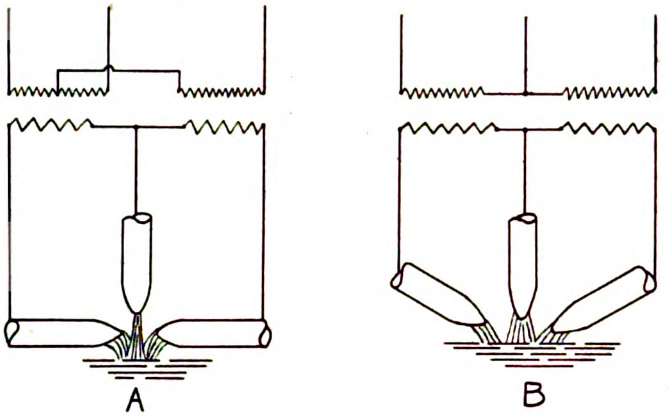

FIG. 3—*Furnace connections.*

(d) Bottom electrodes.

This question is gradually being eliminated in modern furnace design. During the early days of furnace building many installations were placed on the market embodying this feature. The Girod and the Snyder had plugs inserted in the furnace hearth as one connection, but these have never proven satisfactory for many reasons. Today the Greaves-Etchells furnace is on the market using what is known as the "conducting hearth." It is a well known fact that magnesite in the red hot, or high temperature condition, will not conduct current. This furnace has conducting plates on the bottom of the shell as one phase of the current, the efficiency increasing as the magnesite hearth heats up to melting temperatures of the steel bath. It is claimed that by this means melting surges are stabilized, with the lowering of the peak load.

(e) Electrodes.

There is an even opinion at present as to the superiority of graphite or carbon electrodes. In my experience I have found instances where under one condition of operation the graphite was superior, while under slightly different conditions the carbon was favored. The carbon electrodes are stronger, and are favored where irregular sized scrap is to be used; they are used in larger sizes and help to protect the roof from the flame of the arc; they are cheaper per pound. The graphite electrodes offer superior conductive qualities, allowing the use of smaller sizes for a given amount of power; they have a machined joint, eliminating "hot spots"; they are considerably easier to handle. Operating costs per ton of metal will be practically the same for either.

(f) Automatic current regulators.

While there are many furnaces operating on hand control I very strongly favor automatic equipment. There is a saving of time of one man necessary to handle the control, and in addition there is a large saving of current. On some experiments made it was found that the saving of power using automatic against hand control amounted to 50 kw. per ton of metal poured. Then there is the indirect saving due to longer life of the refractories and electrodes. At the present writing there are two good regulators on the market, that made by the General Electric, and the product of Westinghouse, both giving excellent service with very little attention required. In view of the rough usage given these controls it is remarkable the way they will stand up. I have in mind one set which ran for three years under continual working conditions, with green operators, without a single case of trouble.

In closing the electrical side of the electric furnace I might say that there has been a gradual trend away from this question of design. Formerly it was customary to design a furnace around the existing electrical equipment, resulting in furnaces designed by electrical engineers, which were often not too satisfactory from a metallurgical standpoint. Today it is common to first design the furnace for the work it is to do, and then to give thought to the electrical end. This is by far the most satisfactory method of furnace construction, and the point which has resulted in such great steps forward for this equipment. The manufacturers of electrical equipment have gone into this matter so thoroughly that today it is no longer a question of countless calculations to design a furnace, as such apparatus as is desired is a common market product, made by well known and reliable companies, which has been tried and proven in the clash of commerce. Constant experimentation is going on to improve their product, and daily results in increased efficiency are their reward. The 40-ton furnaces at Charleston, and the 60-ton one at the Ford Company, are a great step in advance from the crude apparatus of Siemens.

2—Metallurgical Features.

(a) Hearth.

This is the heart of the electric furnace, and the point to which the greatest attention should be paid.

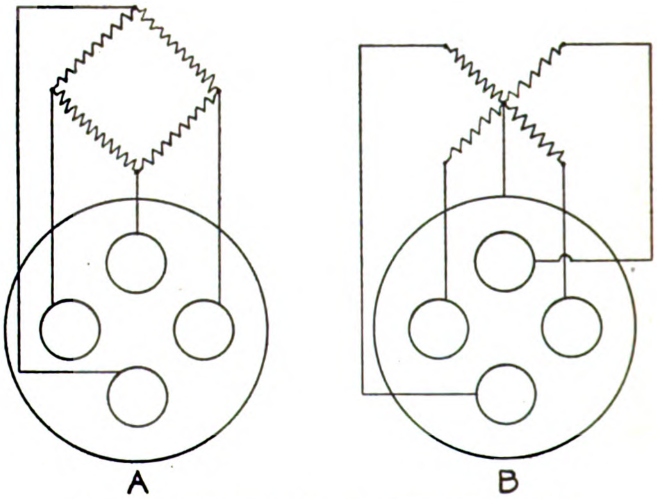

FIG. 4—*Another design of furnace connections.*

Whether for acid or basic operation, the hearth is the metal holding section of the furnace. Regardless of the shape chosen, the hearth should be designed to hold the required amount of metal in the simplest way. Here again there is a vast difference of opinion, some advocating a shallow and wide hearth, while some believe in a deep, well like bowl. I have found in practice that a rather deep hearth favors rapid operation, while a shallow hearth offers the best conditions for refining under a basic slag. The first is therefore recommended where acid operations are desired, while the shallow hearth is desired for basic operation. The area of the hearth should be of such a size that there will be no cold fringe around the walls, and yet large enough so that the arc will not rapidly burn out the sidewalls. Figs. 5, 6, 7, 8 and 9 show the shapes of the hearth on some of the more common modern furnaces.

(b) Walls.

The walls should be just thick enough to give the required strength, and thin enough so that too much waste heat will not be conducted away. This will depend greatly on the size of the furnace. The Heroult furnace recommends a 13-inch wall on their three-ton size, and an 18-inch wall on their larger sizes; the 'Lectromelt uses special brick, which on their three-ton size is 10 inches thick; the Greene furnace uses walls 13½ inches at the hearth, tapering to 9 inches at the roof. I have used a 9-inch wall on a six-ton Heroult, pouring eight tons with the best of success. Walls can be made of different refractories, each used according to the operations. In the great majority of cases, on both acid and basic operation, silica brick walls are used. I know of one large company who is using "Metalkase" magnesite exclusively, and of several who are using carborundum. Then there are many others, such as buaxite, mica schist, zirconium, alumina, etc. There is a new fused magnesite on the market known as "Diamel," which will not shrink and offers wonderful possibilities for the electric furnace.

(c) Roof.

The roof of the furnace will naturally conform to the shape of the hearth, and the standard refractory is silica brick, although carborundum is being used in certain installations. The roof will be arched enough to give strength, and is usually of standard 9-inch thickness, although some are being used in the larger furnaces of 13 inches. There are several makes of patent shaped brick for roofs on the market, excellent claims being made for them by their respective makers. The greatest difficulty I have found with these ready made roofs is the fact that they will not fit the roof ring. Often the roof rings of a furnace will become slightly warped, or will be a little off size. In a case like that the patent roof will prove uneconomical, as a great deal of grinding becomes necessary to give a perfect fit. Fig. 10 shows a patent roof as used on the 'Lectromelt furnace.

(d) Doors.

Doors should be of sufficient size to allow the furnace to be economically charged, and should be as tight fitting as possible. During the finishing operation it is mandatory to allow as little air into the furnace as is possible. Tight doors, which can be sealed, are a great advantage at this stage of the heat. Common fire brick offers a good material for lining the doors, as they are usually of sufficient distance from the electrodes to allow this refractory to hold up. I favor a straight backed door over a rounded one which conforms to the shape of the furnace, as they offer better brick laying features, and better facilities for water cooling.

(e) Electrode arrangement.

A great deal will here depend upon the electrical design of the furnace, some using two, some three, and some four electrodes. The actual arrangement of the electrodes will depend upon the shape of the furnace. Fig. 11 shows a standard arrangement.

(f) Shape of furnace.

Another point where there is a wide array of design. Fig. 6 shows the shape of the different furnaces, looking down onto the surface of the bath. While each of the furnaces on the market at the present time has its excellent points, I slightly favor a round furnace, as it offers the greatest combination of strength and volume in the smallest possible floor space.

3—Mechanical.

(a) Tilting methods.

In my estimation the furnace which offers the most simple and effective tilting method on the market today is the 'Lectromelt, put out by the Pittsburgh Electric Furnace Corporation. The amount of both forward and back tilt is large, and is all that can be demanded. The mechanism of tilting is so synchronized that it can be easily operated with one hand, although most of the installations are motor operated. The new method of tilting the Heroult furnace uses rockers under the furnace, which roll over on a rack, and offers a first class method.

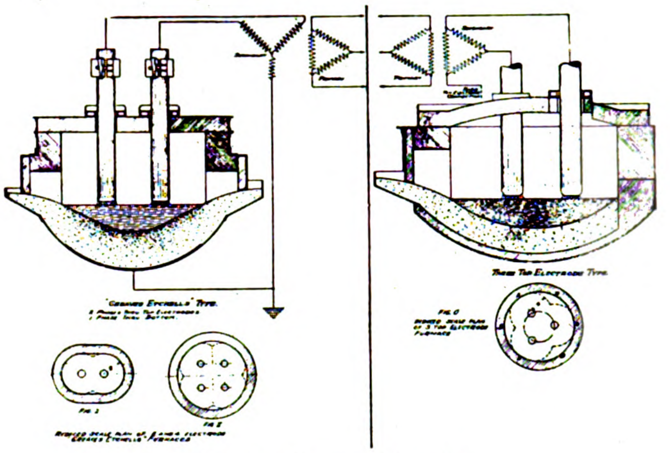

FIG. 5—*Shapes of hearths.*

(b) Electrode holders.

The requirement here is for some apparatus which will hold the electrode in a rigid position, and at the same time have the necessary current carrying ability. There are many different types on the market, each furnace having a different one, some being water cooled. Most of them are made of some elastic bronze, with different methods of locking and tightening.

(c) Cooling rings and economizers.

At the points on the roof where the electrodes enter the furnace there must be some arrangement, fitting around the electrodes, to keep them and the roof cool, and to break the flow of the hot gases and flame from the furnace. If this is not done there will be a heavy consumption of electrodes, a large waste of heat, and a rapid erosion of the roof brick. The general method of handling this is by means of a water cooled collar, resting on the roof, through which the electrodes operate. The joint around the electrode will be as tight as possible in order to choke the amount of flame issuing from the furnace, the less loss the better it is.

(d) General cooling arrangements.

This is a point which is often neglected in the modern furnaces. I believe for best results that as much water cooling as possible should be used. I know of one installation, obtaining very fine results, where practically the whole furnace shell, all the doors, the jambs, and arches are water cooled. They are operating at a favorable power figure, and are obtaining a much increased life of refractories. This is a point to which more attention should be paid by the manufacturer of furnaces, and one which would accrue to his success.

(e) Charging of furnaces.

The greatest waste of time in electric furnace operations is during charging, where hand operations are in vogue. The charging machine made the open hearth furnace, and its lack is tending to hold back the electric furnace. Appreciation of this is shown in several of the existing designs of today. In round furnaces of the Heroult style charging machines can be used on sizes of over eight tons, as has been done for some time at a prominent eastern shop. The Ludlum is so built that a charging machine can be used to good advantage. The 'Lectromelt is so arranged that by tilting the furnace in either direction the charge can be slid in by means of narrow troughs. The Industrial (new Snyder) is so built that the roof can be tilted back and the charge dropped in from a bucket, shaped like the furnace. A very interesting application of mechanical charging is now being used on a 10-ton Ludlum furnace, where the entire body of the furnace is rolled out from under the roof, charged with magnets, and rolled back, the entire operation taking about 10 to 15 minutes, as against nearly an hour for hand charging. There are many methods of paying bonuses to the charging crews, but they are only a means, and can not be at all considered as any sort of remedy.

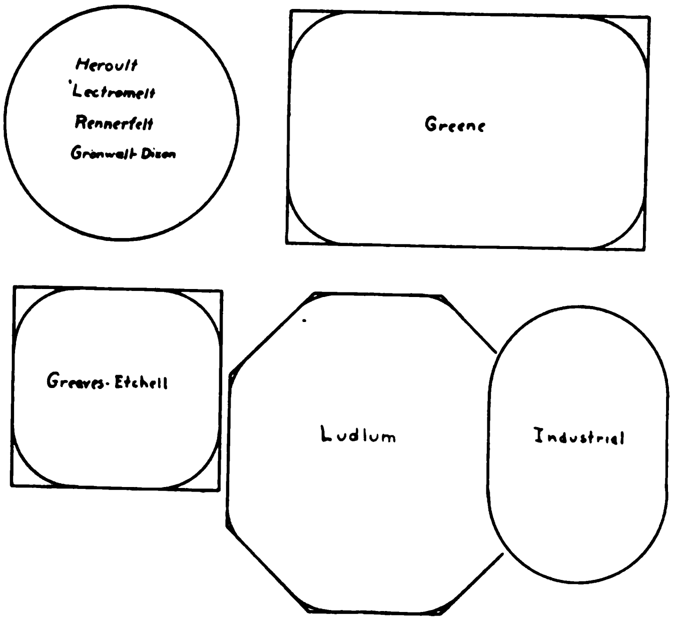

FIG. 6—*Comparison of hearth shapes.*

The foregoing is necessarily very brief, as a complete book could easily be written on the modern furnaces of today. There are many metallurgists and melters in the country who are thoroughly familiar with all of the above described furnaces, and who may not obtain any benefit from the above paper. There are, however, a great many operators who are only familiar with one or two types of furnace, and it is hoped that this attempt may prove of some value in their understanding of the electric furnace.

Science Revolutionizes Pickling

A New Solution of an Old Acid Problem. Guessing By Untrained Men, Now Eliminated, and Accurate Results Obtained Without the Need of Chemists.

By R. S. COCHRANE*

Imagine yourself a pickler. You are responsible for getting out production, keeping down the acid consumption, and producing a satisfactory looking product. You start the morning by filling the vats with water and putting in a certain amount of acid according to your experience. After you have pickled a few batches you add a certain amount more acid. Suppose the action in the vats becomes slow. You *guess* it needs more acid. You realize that temperature also has some effect on the rate of pickling, so you stick your finger into the vat to *feel* if the bath is too cold. You *judge* that one or the other needs attention.

After you have done this all day or for several days, you *guess* it is time to dump the vat, because you *think* you have enough acid and you *feel* the temperature is right, and yet the action is slow. So you dump the vat. Perhaps the vat was not "spent" as you *thought* it was—merely weak in acid—but how could you tell? You couldn't. You may have thrown down the sewer 15 per cent of all the acid you had put into the vat or you may have thrown down 40 per cent. Perhaps you could have run that particular vat a half longer than usual because of some circumstances that you could not observe. Perhaps you have a practice of dumping the vats at stated intervals the same as you take baths once a month, whether you need it or not.

In this enlightened age, it is appalling to think that pickling—a scientific chemical process, subject to scientific laws and capable of being benefited by scientific knowledge—is controlled by feel and guess.

Now imagine that you, having groped about in the dark for years and having learned by cut and try methods at great cost to your employer how to "get by" with the job, imagine then, that you get a chemist in your shop. You wouldn't know what to do with yourself because your big guessing-match would stop at once and you would always *know* what to do. Then suppose your plant is too small to warrant the expense of a chemist and your chemist is suddenly dismissed. You can't manage those delicate glass contrivances, you can't figure the results and you are back in the same darkness as before.

Suppose at this juncture a friend of yours gives you a little dipper and a few capsules that look like quinine pills. He tells you that each capsule is equal to a per cent of acid, so all you have to do when you want to know what is in the vat is to take a dipper full of the liquid, pour it into a milk bottle, and dump into it these pills one at a time until the color changes from red to green. The number of capsules used is the number of per cent of acid. You don't need to hunt the chemist, you don't need to wait until he has figured half a page of figures, you simply get the answer yourself while the chemist would be sharpening his pencil.

These capsules, which are now being marketed for the first time, are a boon to the practical pickler. The chemist has come down from his lofty perch long enough to give him a handy tool that will make his life easier and his costs lower. We call it a first class example of applied chemistry.

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*Assistant Metallurgist, Sharon Steel Hoop Company, Youngstown, Ohio.

Why didn't the superintendent send the chemist down on this job long ago? Let us tell you a little inside information. In his daily sojourns through the plant, the superintendent avoids the pickling department because every time he goes in he embarrasses himself by choking on the fumes, he gets his feet wet, and his nice suit full of acid holes. He considers it a good place to keep away from. No wonder he didn't realize you needed chemical assistance. And, mind you, that same superintendent would not think of rolling a heat of steel if he did not know the analysis of it. A vat of acid going down the sewer doesn't worry him any. He would likely be astounded to know that many of his vats of liquor are discharged containing $25 worth of acid that could have been saved by the use of 50 cents worth of capsules.

The plant manager can now say to his pickle man something of this sort: Start the fresh vat with acid of such strength that it will test between 5 and 7 capsules (0.4 gal. of 60-deg. acid per cubic foot of liquid or 0.056 gal. per gallon); as pickling proceeds add acid from time to time to keep the strength as at the start; when the liquor tests 8 iron capsules, do not add more acid, but continue pickling as long as practicable (the time to discharge the liquor is when the pickling is too slow or when the pickled objects come out too dirty); just before dumping the liquor test it for iron and acid and make a record of the results so that the manager can determine the loss of acid (see chart of acid wasted). If the discharged liquor averages 25 per cent waste according to the chart, it means that one-fourth of all the acid purchased is being wasted. Do not forget that the cost of acid is not the invoice price, but the cost in the vats. It generally pays to waste between 20 and 30 per cent, because to waste less generally means slow pickling. In case the manager decides that under his particular conditions he prefers to use 3 to 5 or 7 to 10 pill acid, this should be adopted as standard for his shop.

PER CENT SULPHURIC ACID WASTED IN DISCHARGED LIQUOR

	Number of Iron Capsules									
Number of Acid Capsules	1	2	3	4	5	6	7	8	9	10
1	36	22	16	12	10	9	8	7	6	5
2	53	36	28	22	19	16	14	12	11	10
3	63	46	36	30	26	22	20	18	16	15
4	70	53	43	36	31	28	25	22	20	19
5	74	59	49	42	36	32	28	26	24	22
6	77	63	53	46	41	36	33	30	28	26
7		67	57	50	44	40	36	33	31	29
8			60	53	48	43	40	36	34	31
9				56	51	46	42	39	36	34
10					53	49	45	42	39	36
11					55	51	47	44	41	39
12						53	49	46	43	41
13							51	48	45	43
14								50	47	45

The neutralizing bath should be tested every morning and should run from 5 to 10 pills. We had thought of making the pills each equal to ¼ per cent of alkali, but upon inquiry we find that these would not be fine enough, so each pill will represent 1/10 per cent alkali as above.

Fig. 1 shows a table to be used which enables the manager to develop efficiency of acid consumption. Most picklers know that the stronger the acid the faster the pickling. But few realize that the stronger the acid the less acid consumed per square foot of surface. A good acid consumption would be 35 pounds per thousand square feet of surface pickled. No matter what the shape or the number of the objects pickled, the surface is easily found on this table if the total weight of the pieces and the thickness of the material are known.

1 cu. ft. of water weighs 62.3 lbs.

1 gal. of water weighs 8.33 lbs.

60-deg. sulphuric acid contains 77.7 per cent pure acid and weighs 14.2 lbs. per gal.

66-deg. sulphuric acid contains 93.2 per cent pure acid and weighs 15.3 lbs. per gal.

Pickle liquor will weigh about 8.6 lbs. per gal. at the start and about 11.2 lbs. per gal. when discharged.

Iron × 5 equals copperas (crystalline).

Iron × 3.56 equals ferrous chloride (crystalline) (in muriatic acid solution).

Soda ash (Na_2CO_3) contains 58 per cent of alkali (Na_2O).

Crystalline soda contains an indefinite amount of alkali, usually about 50 per cent.

Big Construction Projects in Canada

Harbor Improvements on Prince Edward Island. Ten Million Bushel Wheat Elevator in Montreal Authorized. Department Store and Apartment House In Montreal. Hydroelectric Projects.

The House of Commons has authorized an expenditure of $296,700 for the improvements of harbors and rivers. Considerable new work will be undertaken in construction of breakwaters and wharves throughout the province, says Vice Consul Arthur B. Giroux, in a report to the Department of Commerce.

Great Wheat Elevator in Montreal Authorized.

The government at Ottawa has approved the construction of an elevator by the Montreal Harbor Commission which will have an ultimate capacity of 10,000,000 bushels, to be constructed in units of two and a half million bushels capacity. The first section, which is to cost $2,347,000. will be started soon. An enlargement of the former Grand Trunk Grain Elevator will be undertaken; the work is expected to cost approximately $750,000 according to a report to the Department of Commerce from Consul General Albert Halstead.

Department Store and Apartment House In Montreal.

It is also reported by Consul General Halstead that a nine story department store and an apartment house of 250 apartments will be erected in Montreal.

Filtration Plant in Ontario.

The installation of a filtration plant in the Province of Ontario has been recommended, Consul Felix S. S. Johnson, Kingston, reports.

Hydroelectric Developments in Ontario.

Several power companies in Ontario are planning extensive developments of hydro-electric energy, Vice Consul Harold S. Tewell, North Bay, Ontario, reports.

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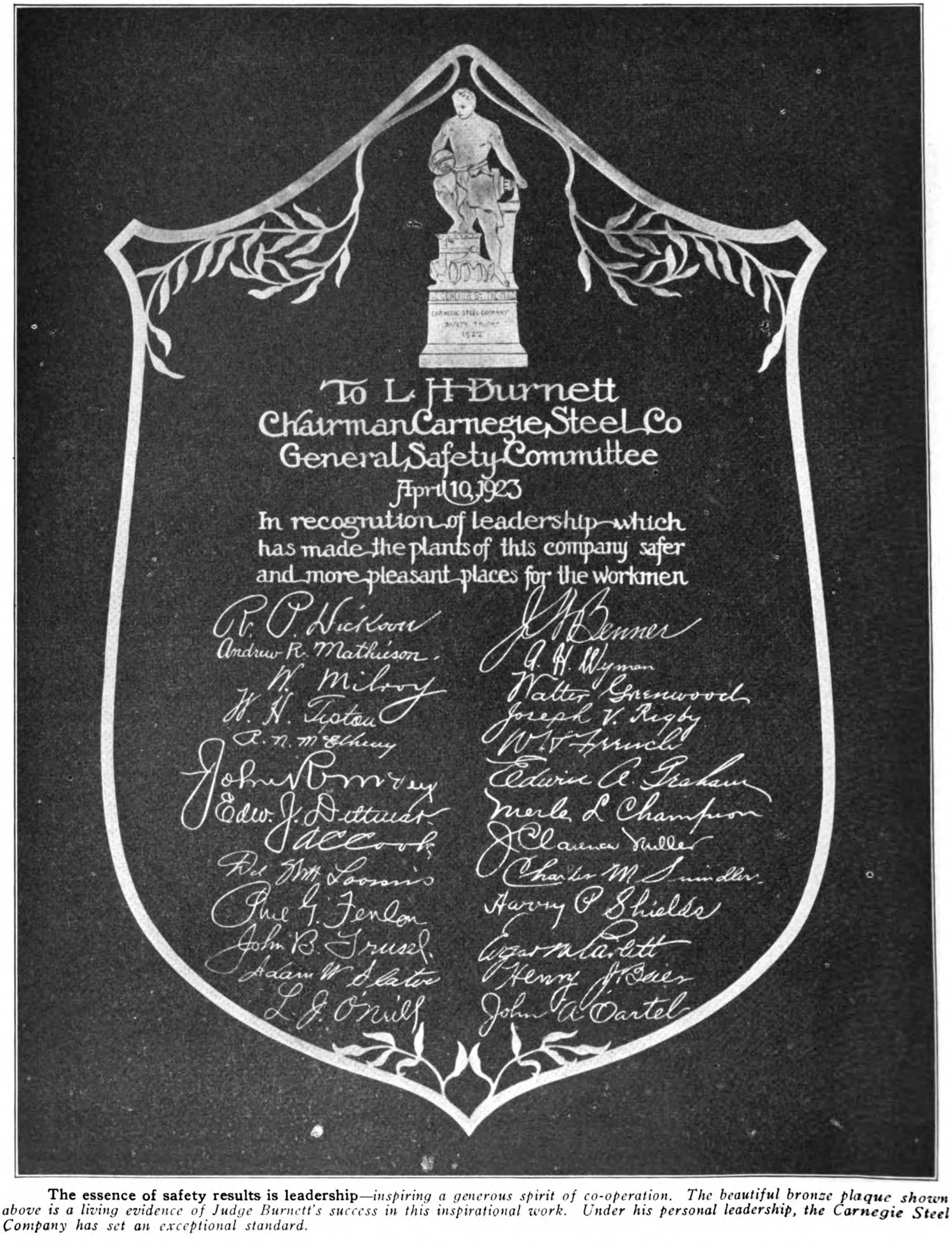
THE SAFETY CRUSADE


CARNEGIE STEEL COMPANY
SAFETY TROPHY
1922

To L. H. Burnett
Chairman Carnegie Steel Co
General Safety Committee
April 10, 1923
In recognition of leadership which
has made the plants of this company safer
and more pleasant places for the workmen

R. P. Hickson
Andrew R. Mathieson
W. Milroy
W. H. Tipton
A. N. McElheny
John N. Ramsey
Edw. J. Dittmar
A. C. Cook
Wm. Loomis
Phil G. Fenlon
John B. Trusel
Adam W. Slater
L. J. O'Neill

J. H. Benner
A. H. Wyman
Walter Greenwood
Joseph V. Rigby
W. V. French
Edwin A. Graham
Merle L. Champion
J. Clarence Miller
Charles M. Swindler
Harvey P. Shields
Edgar M. Parlett
Henry J. Baer
John A. Oartel

The essence of safety results is leadership—*inspiring a generous spirit of co-operation. The beautiful bronze plaque shown above is a living evidence of Judge Burnett's success in this inspirational work. Under his personal leadership, the Carnegie Steel Company has set an exceptional standard.*

Short Method for Figuring Alloys

A Comprehensive System of Tables and Proportions Used by Practical Steel Makers.

By J. M. QUINN

PART II

IN the April issue, pages 232-238, appeared a most comprehensive system of tables and proportions, designed for practical use of steel-makers. While the complete tables of factors were not printed, as they occupy 20 full magazine pages, they are available upon written request.

The subject is of constantly increasing importance, owing to growth of alloy production.

To further add to the fund of necessary knowledge and information, the author has extended the article to include a listing of all commercially used elements, with comparative melting ranges. It will be noted in many cases, that the melting ranges extend over a wide interval of temperature and good agreement is not always found among different observers. These divergencies are undoubtedly caused in part at least, by the varying amount of impurities in the specimens, differences in calibration bases, atmosphere and experimental arrangement.

While the melting points of the above alloys give some information to the steel and iron maker, they do not play the dominant part as the most important feature is really that of "solubility point." That is to know the temperature at which the alloys go into solution in the steel and iron. However, no data is available on solution points of alloys although the Bureau of Standards expects to experiment this line in the near future.

DATA ON ABOVE ALLOYS

Chromium.

Ninety-seven to 99 per cent carbon free chromium (1) is used chiefly in the production of special alloys of high chromium content and its cost is high—used in the manufacture of high resistance wire such as nicrome—also for non-ferrous metals such as "stellite". It is a silver colored brittle metal and its fracture shows no grain or fibre.

Sixty per cent carbon free chromium (1) is used by manufacturers of chrome steel where low carbon content in the steel is important or close carbon limits are specified—also in stainless steel which is about .20 per cent to .40 per cent carbon and 12 per cent to 17 per cent chromium. Its appearance is similar to the 97 to 99 per cent metal.

Sixty-seven per cent ferro chromium (high carbon) (2) containing approximately 6 per cent carbon does not have a definite melting point, but passes through a mushy stage as the metal cools from the temperature at which solidification starts.

Sixty-seven per cent ferro chromium (low carbon) (2) containing about 2.70 per cent carbon has a fairly definite melting opint at approximately 1500 deg. C.

Cobalt.

Ninety-seven to 98 per cent carbon free cobalt (1) is used principally in the manufacture of "Stellite" and high speed tool steels. It is believed by some authorities that when 4 per cent or 5 per cent of cobalt is added to high speed steel containing 15 per cent to 18 per cent tungstein, the cutting quality is greatly enhanced. Cobalt is very tough and fibrous and cannot be crushed.

Manganese.

Ninety-four to 98 per cent carbon free manganese (1) is used in the manufacture of the highest grade of manganese — copper, nickel castings, cupro nickel, nickel silver and other special alloys. It is a very light steel grey color and brittle with a fine dense grain.

Eighty per cent ferro manganese (4) analizing approximately 78 to 82 per cent manganese, 6 to 7 per cent carbon, about 1 per cent silicon, under .25 per cent phosphorus, trace of sulphur is used extensively in steel manufacture for deoxidizing and alloying with metal. This alloy is a steel grey color and brittle.

Manganese Titanium (1) analizing approximately 55 per cent manganese, 30 to 35 per cent titanium, 5 per cent aluminum, 2.5 per cent silicon and 2.5 per cent iron is a very powerful deoxidizer and is used chiefly in non-ferrous metals, although during the war this alloy was used in connection with the manufacture of forging steel. The alloy is a dull grey color.

Molybdenum.

Fifty to 60 per cent ferro molybdenum (5) containing less than 2 per cent carbon is used principally in the manufacture of medium carbon alloy steels. Molybdenum resembles platinum in physical appearance and possesses a peculiar luster, it alloys readily with iron and resists most acids and chemicals to a marked degree.

Nickel.

Ninety-nine and 96 per cent nickel (10) is used extensively in the ferrous and non-ferrous industry. The equilibrium diagrams indicates that each 1.0 per cent manganese lowers the melting point approximately 5 deg. C. and that .10 per cent carbon lowers the melting point about the same. The A and D grades both contain approximately .10 per cent carbon and the calculated melting points are shown above.

Silicon.

Fifteen per cent, 50 per cent, 60 per cent and 75 per cent ferro silicon (2) is used in the manufacture of many grades of steel and iron as deoxidizers and alloying agents. The melting point curve for ferro silicon shows two eutectics at 20 per cent and 60 per cent respectively and it will be noted that the 50 per cent and 75 per cent ferro silicon melt at the same temperature. Fifty per cent ferro silicon is brittle and slightly

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*Superintendent of Refinery, International Nickel Company, Huntington, W. Va.

ANALYSIS OF VARIOUS COMMODITIES FROM THE IRON AND STEEL INDUSTRY

Commodities Name Alloys Symbol	Boron B	Carbon C	Manganese Mn	Sulphur S	Phosphorus P	Silicon Si	Iron Fe	Aluminum Al	Copper Cu	Oxygen O	Cobalt Co	Tungsten U	Source of Data
Boron—Ferro	32.75	2.87		.030	.005								Bureau of Mines Bulletin 77, Washington, D. C., 1916.
Boron—Ferro	17.00					1.00		6.00					Metal & Thermit Corp., New York City, N. Y., 1921.
	Chromium Cr												
Chromium—Ferro	65.90	8.58	.44	.020	.020	1.26	23.44	.18					Western Steel Co., Chicago, Ill., 1909.
Chromium—Ferro	64.17	2.34	.21	.023	.020	.38	32.47	.13					Western Steel Co., Chicago, Ill., 1909.
Chromium—Ferro	70.05	5.46		.060	.047								National Alloy Corp., Philadelphia, Pa., 1921.
Chromium—Ferro	60.05	.20			.136	.87							Metal & Thermit Corp., New York City, N. Y., 1921.
Chromium—Ferro	60.25	.12				1.22		1.88					Metal & Thermit Corp., New York City, N. Y., 1921.
Chromium—Ferro	63.65	4.08				4.05							U. S. Ferro Alloy Co., Niagara Falls, N. Y., 1921.
Chromium—Tungsten-Ferro	50.00	2.00					25.00					22.00	Electro Metallurgical Sales Corp., New York City, N. Y., 1922.
Iron—Basic Pig Lake Ore		4.03	1.30	.027	.138	.98							No. 5 Blast Furnace, Western Steel Co., 1914.
Iron—Basic Pig Adrian		4.00	.60/.90	under .010	.50/.70	4./6.							Adrian Furnace Co., Du Bois, Pa., 1920.
Iron—Basic Pig		3.73	.30	.015	.800	2.40							Adrian Furnace Co., Woodward, Ala., 1915.
Iron—Basic Pig		3.95	.168	.064	.202	1.09							Frodingham, England, 1915.
Iron—Acid Pig—Low Phos.		3.5/4.	.40/.6	under .035	under .035	1./2.							Hickman Williams Co., Chicago, Ill., 1910.
Iron—Acid Pig—Low Phos.		3.65	.46	.019	.037	1.79							Thomas Furnace Co., Milwaukee, Wis., 1914.
Iron—Acid Pig—Low Phos.		3.75	1.40	.032	.050	2.94							Gartshenie Hematite, England, 1910.
Iron—Swedish Charcoal Pig		2./3.75	.20/.8	.01/.015	.02/.025	.40/.6							Debevoise-Anderson Co., New York City, N. Y., 1921.
Iron—Ingot		.01	.003	.015	.001	.002				.012			Chemical & Metallurgical Engineering, Vol. 8, 1910.
Iron—Low Carbon Iron		.10	.35	.037	.065	.012				.034			Chemical & Metallurgical Engineering, Vol. 8, 1910.
Iron—Melting Bar—Grade No. 1		.10		under .012	under .012								Monongahela Iron & Steel Co., Pittsburgh, Pa., 1920.
Iron—Melting Bar—Grade No. 2		.20	Low	under .015	under .015	Low							Monongahela Iron & Steel Co., Pittsburgh, Pa., 1920.
Iron—Swedish		.09	.08	.011	.011	.10							U. S. High Speed Steel & Tool Corp., Green Island, N. Y., '21.
Iron—Wash Metal		3.53	.07	.008	.006	.10							U. S. High Speed Steel & Tool Corp., Green Island, N. Y., '21.
Manganese—80% Ferro		6.99	80.30	.020	.160	.40	12.13						Blast Furnace Product, Western Steel Co., Chicago, Ill., 1914.
Manganese—80% Ferro		5./9.	78./82.	under .030	.1/.3	.5/1. 1.72	15.80						Crocker Bros., New York City, N. Y., 1921.
Manganese—80% Ferro		4.72	77.85			2.14	11.10						Southern Manganese Corp., Anniston, Ala., 1917.
Manganese—80% Ferro		5.92	80.43										Southern Manganese Corp., Anniston, Ala., 1917.
Manganese—Low Carbon-Ferro		.12	93.04			.39	about 7.00						Electro Metallurgical Sales Corp., New York City, N. Y., 1922
	Molybdenum Mo												
Molybdenum—Ferro	50.55	.73		.190	.078	.94							Bureau of Mines Bulletin 77, Washington, D. C., 1916.
Molybdenum—Ferro	56.90	1.21		.220	.030	.62			.08				Climax Molybdenum Co., New York City, N. Y., 1921.
	Nickel Ni												
Nickel—99%, Grade A	99.05	.10		.040		.10	.47		.15		.80		International Nickel Co., Perth Amboy, N. J., 1921.
Nickel—96%, Grade D	96 00	.10	.300	.040		.10	.47		.15		.80		International Nickel Co., Perth Amboy, N. J., 1921.
Nickel—Ferro	41.50	1.34		.040		4.33	51.60	.81					Bureau of Mines Bulletin 77, Washington, D. C., 1916.
Nickel—Anodes	98,82	1.70				.50	.80	.03	.15				Marcia, Chemical & Metallurgical Engineering Vol. 24, 1921.

COMPARATIVE MELTING RANGES OF SOME METALS AND ALLOYS IN DEGREES CENTIGRADE

Commodities	Bureau of Standards	Other Observers
Aluminum, Pure	659	659 (3)
Boron, Pure	2200-2500?	
Chromium, Pure	115	
" 97./98.% Ferro, Carbon Free	1519	1515 (1)
" 60.% Ferro, Carbon Free	1395	1382 (1)
" 65./70.% Ferro, C. 2.00%	1402-1560	1500 (2)
" 65./70.% Ferro, C. 5.00%	1333-1516	
" 67.% Ferro, C. 6.00%		1200-1300 (2)
" 65./70.% Ferro, C. 10.00%	1301-1600	
Cobalt, Pure	1480	
" 97./98.% Ferro, Carbon Free	1475	1475 (1)
Iron, Pure	1530	
" Wrought ......C. 0.06% Slag ...1.00%		1600 (1)
Soft Steel .....C. 0.10% Mn 0.30%		1475 (7)
Medium Steel C. 0.30% Mn 0.20%	1300-1485	1455 (7)
Medium Steel C. 0.52%	1275-1470	
Hard Steel ....C. 0.90% Mn 0.10%	1215-1475	1410 (7)
Hard Steel ....C. 1.15%	1120-1370	
Fdy. Iron .....C. 3.50% Si 1.75%		1220 (7)
Fdy. Iron .....C. 3.33% Si 1.82%	1160-1210	
White Iron ...C. 4.00%	1125-1162	1135 (7)
Manganese, Pure	1230	
" 95./98.% Ferro, Carbon Free	1225	1225 (1)
" 80.% .... C. 6.00%	1255-1263	1250-1275 (4)
" Spiegel .... Mn. ...20.00%	1070-1240	
" Titanium....Mn. 55.% Ti. 30.%		1205 (1)
Molybdenum, Pure	2550	
" 67.% Ferro, C. 0.30%		1630 (5)
" 60.% Ferro, C. 0.30%		1630 (2)
" 59.% Ferro, C. 0.60%		1465 (5)
" 53.% Ferro, C. 1.50%		1455 (5)
" 50.% Ferro, C. 2.00%		1450 (2)
" 60.% Ferro, C. 2.00%		1510 (1)
Nickel, Pure	1452	
" 99.% Grade A ...... C. 0.10%		1445 (10)
" 96.% Grade D ...... Mn. 3.00%		1430 (10)
Silicon, Pure	1420	
" 15.% Ferro		1280 (2)
" 33.%	1322-1497	
" 50.%		1360 (2)
" 60.%		1250 (2)
" 75.%		1360 (2)
" 92.%	1330-1418	
Titanium, Pure	1800	
" 25.% Ferro,Carbon Free		1204 (1)
" 25.% Ferro, Metal	1772	
" 16.% .... C. 7.50%		1400-1450 (6)
Tungsten, Pure	3400	
" 80.% Ferro, Carbon Free		2600 (3)
" 80.% Ferro, Carbon Free		1800-1900 (2)
Uranium, Pure	1850	
" 35.% Ferro .... C. 1.00%		1600 (8)
Vanadium, Pure	1720	
" 35.% Ferro		1525 (8)
" 33.% Ferro, High Silicon		1250 (9)
" 33.% Ferro, Low Silicon		1400 (9)
" 15.% Ferro, Low Silicon	1620	
Zirconium, Pure	1700?	

Notes—
(1) Metal & Thermit Corp.
(2) Mass. Institute of Tech.
(3) Ajax Electrothermit Corp.
(4) National Alloy Company.
(5) Climax Molybdenum Co.
(6) Titanium Alloy Mfg. Co.
(7) Chemical Met. Hand Book.
(8) Standard Alloys Co.
(9) Vanadium Corp. of America.
(10) International Nickel Co.
(11) Westinghouse Elec. Mfg. Co.

fibrous, the fracture is very bright and of a steel grey color. The 50 per cent alloy will not disintegrate, but as the silicon approaches 55 per cent, disintegration is quite frequent. It is very soluble in steel and iron.

Titanium.

Twenty-five per cent carbon free titanium (1) analizing 25.50 per cent titanium, .60 per cent manganese, 0 per cent carbon, 5.75 per cent aluminum, .35 per cent silicon is a well known deoxidizer and cleanser for steel and iron. This alloy produced by the alumino-thermic process is claimed to be free from carbon and injurious and insoluble carbides. Because of this it melts and alloys very readily with steel and iron.

Fifteen per cent ferro carbon titanium (6) analizing 16 per cent titanium, .10 per cent manganese, 7.50 per cent carbon, 1.40 per cent silicon, .08 per cent sulphur, .05 per cent phosphorus and balance iron is also a well known deoxidizer and cleanser for steel and iron. The carbide of titanium is at least as effective a deoxidizer as metallic titanium and is considerably cheaper.

Tungsten.

Eighty per cent ferro tungsten is used principally in the manufacture of 14 per cent to 18 per cent tungsten high speed steel and 2 per cent to 5 per cent tungsten magnet steels. Ferro tungsten is brittle and generally of a very light steel grey color and of extremely fine grain.

Uranium.

Thirty to 40 per cent ferro uranium (8) containing less than 1 per cent carbon and 2 per cent silicon is added to certain steels as a deoxidizing and alloying agent. Dr. George K. Burgess of the Bureau of Standards states that unlike zirconcium and titanium, uranium appears to enter into solution in steel that is, it is a true alloying addition. Uranium metal is white and takes a polish like iron. It may be filed easily and does not scratch glass. When containing carbon it becomes very hard and shows a crystalline fracture. This form is quite pyrophoric readily giving sparks when scratched with a hard object, or rubbed with a piece of the same material.

Vanadium.

Thirty-three to 35 per cent iron vanadium (8) is sometimes considered the eutectic as some authorities give the eutectic formation at 32 per cent and others show it as high as 35 per cent vanadium. Ferro vanadium (1) is used extensively in conjunction with chromium in the manufacture of steel. It is a granular steel grey alloy, is quite brittle and is very soluble in steel and iron.

The melting point (9) primarily depends on the vanadium content in the alloy, the lowest melting point corresponds to a vanadium percentage of about 32.5 per cent in the alloy. For this same vanadium percentage, however, the melting point is considerably affected by the percentage of silicon. The 32.5 alloy shows a melting point of 1400 deg. C. to 1250 C., the lowest melting point corresponding to the highest silicon content.

ALLOYS—Continued

Ferro phosphate, ferro silicon, ferro silicon Mn., ferro silicon spiegel, spiegeleisen, ferro tungsten, ferro uranium, ferro vanadium.

Ferro zirconium, calcium silicide, magnesium manganese silicon, nickel zirconium, S. A. M., silicon zirconium, titanium 15 per cent and 25 per cent, ferro zirconium silicon, cerium alloy.

Oxidizing Agents.

Cinder—plate mill. Ore—chrome, colemanite, hand and soft, manganese, molybdenite, wolframite. Scale—mill. Ore—titaniferous.

Refractories.

Brick, alumina, carborundum, chrome, clay, magnesite, silica, zirkite.

Fluxes.

Lime burnt, lime stone, sand silica spar fluor.

Lining Materials.

Carborundum, dolomite, prepared dolomite, ganister.

Magnesite — Austrian, California, electric. Mica schist, sand furnace bottom, zironium oxide.

Clay and Other Binders.

Clay—Fire, plastic, silica. Loam, kanolin, hytempite cement, obturit cement, sodium silicate.

Miscellaneous Materials.

Charcoal, coal, hard and soft; coke, electrodes, carbon raiser, ashes from coal, gas—producer, coke oven; nozzle clay, sleeves clay, stopper heads clay, stopper heads graphite, iron molds.

Acid slags electric furnace oxidizing, reducing. Basic slags electric furnaces several making different steels; acid open hearth slags, basic open hearth slags, blast furnace slags.

Acid electric furnace bottom and side walls, same after 27 heats. Stalacitites in basic electric furnace roof; fumes from basic electric furnace; fumes from volatilization of silicon in basic electric furnace. Sonims (several).

Gray iron, malleable before and after anneal, semi steel, synthetic pig, high speed, cobaltcom, stellite, silicrome, stainless steel, ghost liner in steel, cerium steel.

Comments.

It will be noted in many cases, that the melting ranges extent over a wide interval of temperature and good agreement is not always found among different observers. These divergencies are undoubtedly caused in part at least, by the varying amount of impurities in the specimens, differences in calibration bases, atmosphere and experimental arrangement.

While the melting points of the above alloys give some information to the steel and iron maker, they do not play the dominant part as the most important feature is really that of "solubility point." That is to know th temperature at which the alloys go into solution in the steel and iron. However, no data is available on solution points of alloys although the Bureau of Standards expects to experiment along this line in the near future.

The Acme Steel Goods Company, Chicago, Ill., is constructing two cold roll strip mills to its plant at Riverdale on the Calumet River.

The buildings are expected to be completed during this spring or summer, and will have an annual capacity of 30,000 to 40,000 tons of cold rolled strip steel. The latest and most modern up-to-date equipment will be installed and will be the last word in strip mill equipment. It will produce cold rolled strip steel from 3 to 20 inches wide, which is the largest width made.

Approximately 900 men are now employed, and an additional 200 men will be required.

CHANGE IN SALES METHOD

Beginning June 1, 1923, Universal cement will be sold and invoiced by the sack instead of by the barrel.

On cement sold prior to that date, the price per sack will be determined by dividing by four the price per barrel. On quotations and sales made on and after June 1, the price will be figured by the sack.

Modern Sheet Mill Practice*

A Concise Description of the Practical Aspect of Sheet Mill Practice—High Degree of Skill Required of Operators—Recent Development Tending Toward the Combination of One Roughing Stand Between Two Finishers.

As the construction of several important sheet mills is now nearing completion, a short description of sheet mill practice may not be out of place. In many features, sheet mill practice differs radically from any other mill practice, excepting that followed in tin mills. As the steel being rolled is very thin, it will chill quickly unless the rolls are run very hot, consequently no water is used on the rolls, and the sheets are rolled in packs, i. e., several thicknesses at a time placed on top of each other and all rolled at the same time.

28-in. and 32-in. sheet and jobbing mills installed at the Apollo Steel Company. This installation consists of one 28-in. and one 32-in. roughing stand and two 28-in. and two 32-in. finishing stands for sheets, two 32-in. jobbing mills and two 26-in. cold mills, one at each end of the train.

Two pieces of steel, commonly known as Sheet Bar, ranging in thickness from 5-16 in. to ⅞ in. x 8 in. wide, of a length approximately the width of the sheet to be rolled are brought from the furnace, called a "pair furnace" because the sheet bars are always handled in pairs. Sheet bar is known by its weight per foot. For instance, .525 in. by 8 in. bar is known as 12-pound bar because it weighs 12 pounds per running foot. One man is stationed on each side of the mill, the one on the furnace or front side called a "roller," and the one on the other side called the "catcher." Both pieces are thrown onto the foreplate, which is a flat plate on the entering side of the mill. With his tongs, the roller pushes the top bar into the rolls so that the length of the bar is parallel to them. The "catcher" catches it with his tongs as it comes through and by a peculiar swing throws it up on top of the top roll. The "roller" pushes the second bar into the "bite" of the rolls and then quickly catches the front end of the first rolled bar now coming over the top roll, and lets it drop onto the foreplate and shoves it into the mill. This process of rolling and passing over takes place three or four times for each bar, and it is done so quickly that one piece has hardly left the mill before the next one enters. The two pieces are now matched, i .e., one laid on top of the other and given one pass through the mill, generally on the finishing mill but sometimes on the rougher. They are then placed in a pile on the floor on the catcher's side.

This matching is an operation requiring much skill, and the same might be said of every operation about a sheet mill, from the proper heating to the shearing, and any after treatment the sheet is to receive.

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*United Effort.

In the case of lighter gauges, the sheets are doubled back on themselves before reheating and the bend flattened down in a doubling machine, making a pack four sheets thick. For still lighter gages, instead of two sheets being laid on top of each other, there are three, making when doubled over, a pack of six sheets thick. The sheets are now reheated and taken to the finishing stand, where the same rolling and passing over process takes place. On this stand there are rolled two, three, four, or six thicknesses at a time, depending on the gage. For some gages, a third heating is required.

From here, they go to the squaring shears, where they are cut square and straight along all four edges and to size, and the pack is then opened, i.e., the sheets are separated from each other. They are then given one or more passes, singly, through a cold mill, so called because both the rolls and the sheets are cold, and are then taken to the picklers, where they are immersed in steam heated baths of dilute sulphuric acid. They then go to the annealing furnace where they are held, so covered as to exclude air, for from 10 to 15 hours at a temperature of from 1200 deg. to 1500 deg. F. This removes the strains caused by the rolling, removes brittleness and ordinarily finishes operations on the sheet.

While the foregoing describes the generally accepted practice, in some mills there are variations made, and the use to which the sheet is to be put will cause a different procedure to be followed. In some cases, the sheets are annealed and pickled oftener than mentioned, and a large proportion are galvanized.

The work around a sheet mill is heavy but at the same time must be quickly done, and the large amount of hot sheet exposed and the furnaces render the work extremely hot. On account of the necessity of keeping the rolls hot, the mills run day and night, generally from midnight on Sunday until 8 o'clock the following Saturday morning. This makes sixteen 8-hour shifts per week. While mechanical means have been tried to perform some of the operations, by far the greater part of the work is still done by hand.

The mills are all two high, and in the past American practice has been to use 28 in. rolls at about 30 r.p.m. Later practice, however, seems to call for 30 in. rolls. The mills we are at present building have 30 in. diameter rolls. The housings are cast steel weighing about 35,000 pounds each.

The Sheet Mills recently built for the National Enameling & Stamping Company consist of six finishing stands, six roughing stands, two cold mills, as well as one roughing and one finishing stand jobbing mill driven by a 2,000 h.p. motor.

Originally, sheet mills were built with one roughing stand located between each two finishing stands, and this roughing stand roughed the sheets for both finishing stands. The next development was to have one roughing stand for each finishing stand, but the trend now is to revert to the former arrangement. The size of a sheet mill means the number of finishing stands, disregarding the number of roughers. Thus a plant with four finishers and two roughers would be known as four mills.

The mills now building for the Weirton Steel Company are arranged in two trains, each train driven by a 1200 h.p. motor. Each motor drives four finishing mills, two roughers and two cold mills.

A hot mill will require about 175 to 200 k.w. per roll stand, and a cold mill about 40 to 50 k.w. A great part of this power, possibly more than 50 per cent, is consumed in friction.

A fair average production for a sheet mill may be considered to be about one ton per hour per finishing stand, although this, of course, varies widely depending upon the gage being rolled. The same variation will be found in the k.w. hours per ton, which may run from 80 to 175.

PIG IRON RECORD SET BY FURNACE IN OHIO

Another world record for production of pig iron was established by the Warren stack of the Trumbull-Cliffs Furnace Company, of which the Trumbull Steel Company owns half, when one day in March it produced 1,011 gross tons of pig iron. The record was made with the stack working on a mixture of ore and scrap.

The total production for March was 24,758 tons of iron, said to be the highest tonnage ever produced in any one month by any furnace in the world. The daily average was 798.6 tons, as compared with 766 tons in February and 753 tons in January, when the furnace worked exclusively on ore.

The ratio of scrap to ore used was about one and one-half tons to six and one-half tons of ore.

Strip steel production by the Trumbull steel broke the monthly record with 21,752 tons produced.

NEW HEAVY DUTY ROLLER BEARING

A new spherical roller bearing for heavy duty service in connection with steel mill motors, rolling mills, tube mills, rotary furnaces, railway journal boxes, hoisting and other machinery, has been brought out by the S. K. F. Industries, Inc., 165 Broadway, New York. The new design is intended to incorporate the desirable characteristics of both ball and roller bearings, and in equivalent sizes is said to have about twice the load capacity of the corresponding ball bearing.

The bearing is a self-contained and self-aligning unit. When it is being installed no internal adjustment of the bearing itself is necessary, which eliminates the possibility of damage through initial maladjustment. Shaft deflections and inaccuracies in machining and locating the housing are compensated for in the self-alignment feature provided by the spherical surface of the outer race.

The rollers are barrel shaped, and have their largest diameter toward the inboard end. On the inner race the roller contacts with groove throughout its length, thus providing the line contact of the roller bearing. There is a substantial area of contact between the roller and the outer race, due to the elasticity of those parts an dconsequent deformation under load. In this way the new bearing incorporates the theoretical characteristics of both the point contact of the ball bearing and the line contact of the roller bearing.

Parallelism of the axes of the rollers with the axis of the shaft is accomplished by means of the guiding flanges on the inner race. Both the flanges and the ends of the rollers are ground spherical surfaces, with their center at the point of intersection of the shaft axis and the axes of the rollers. The guiding flanges and the roller ends have the same center and the same radius of curvature.

CURRENT TECHNICAL DIGEST

EXPLOSION TESTS

Sixteen years ago Uncle Sam officially announced his intention to study the problems pertaining to the use of explosives in industrial work.

Admitting that there is much yet to be done towards increasing safety, efficiency, and economy in the use of explosives, anyone who is familiar with conditions that existed sixteen years ago and those of today must acknowledge that real progress has been made; and that government research and recommendations have brought about much of the improvement.

The first official cognizance of explosives for mining was given by the Technologic Branch of the United States Geological Survey. This division, which was started in 1907, took over the work of a department created in 1904 to investigate the mineral fuel resources of this country. Dr. Joseph A. Holmes was in charge of the division from its inception. He foresaw the need for an experiment station equipped with research laboratories for chemical and physical investigation of mine gases, explosives, mine lamps, as well as mining equipment. It was also his conception that this station should help to eliminate wasteful and unsafe mining methods. In July, 1907, the study of causes of mine accidents was officially started under his direction, and a bulletin on the causes and prevention of coal mine accidents was soon published.

After inspections and studies of foreign methods, plans were made for a government testing station in this country. The completion of these plans was hastened by a series of disastrous coal mine explosions, which so aroused public opinion that the Secretary of the Interior, James R. Garfield, immediately requested Belgium, England, and Germany to send their most experienced representatives to co-operate with Dr. Holmes in studying mining conditions in this country and in framing a series of recommendations on how to best increase the safety and efficiency of coal mining in the United States.

The most important result of these recommendations was the introduction of permissible explosives and the establishment of a testing station at Pittsburgh.

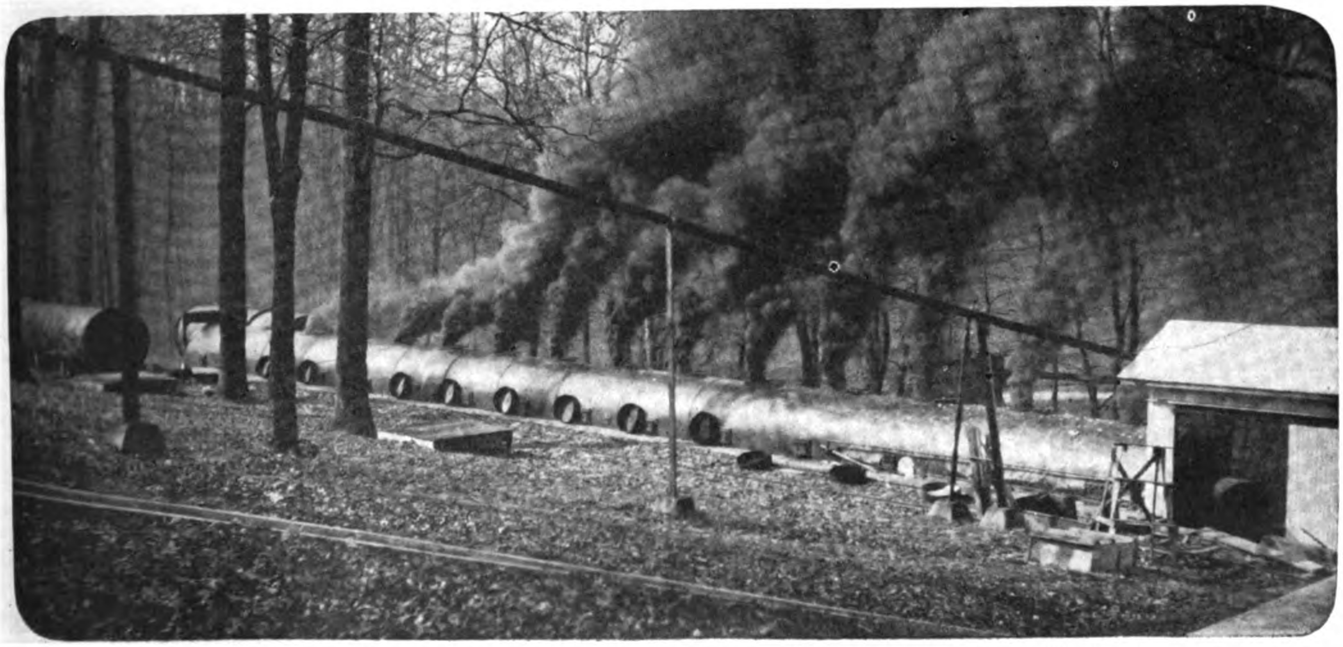
On January 8, 1909, the director of the United States Geological Survey notified the manufacturers of explosives in the United States that any explosives they might desire would be officially tested for classification as permissible for use in gaseous and dusty coal mines.

The Unied States Bureau of Mines was created by an act of May 16, 1910, "to make diligent investigations of the methods of mining, especially in relation to the safety of miners, the use of explosives and the prevention of accidents, and other matters relating to mining." Dr. Holmes was the first director of the Bureau.—The Explosives Engineer for March.

MEXICO FORGING AHEAD

Radio Transmitting Sets for the Mexican National Radio System.

To the average individual in this country the mention of radio brings to mind only the fascinating inter-



Explosibility ignition test in experimental gas and dust gallery, Bureau of Mines, Pittsburgh.

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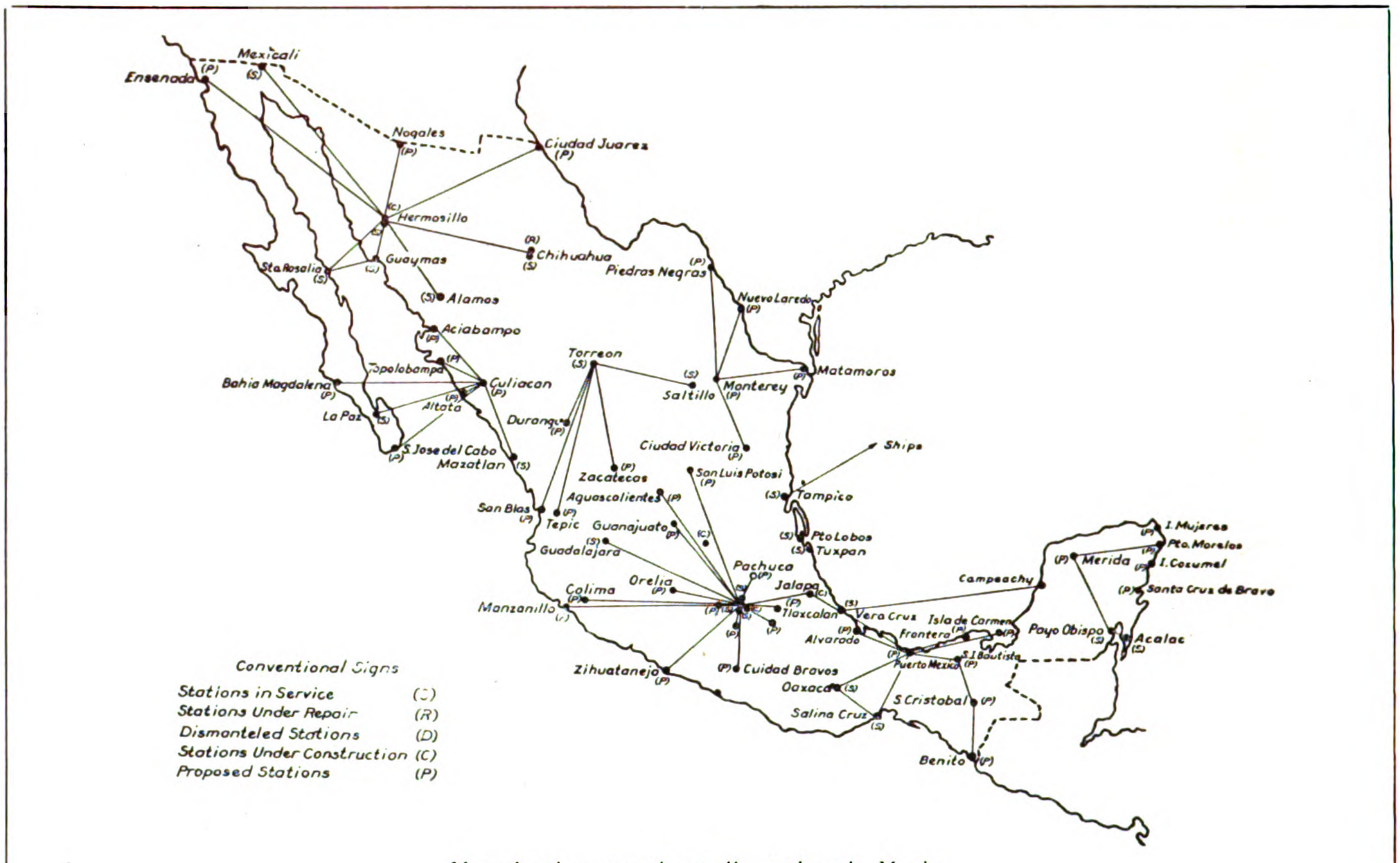
est that is connected with the reception of the entertaining programs which are broadcasted daily. For him it would be instructive to learn of the less sensational but more valuable application of radio to commercial communication. For example, the Government of Mexico proposes to cover its territory with a net work of radio telegraph stations furnished with the most modern vacuum-tube equipment. This plan calls for the installation of some 42 radio "central stations" and "substations."

The system contemplated involves the erection of forty-two stations, in addition to those already in operation. Of the new stations, four will be so-called "central stations" and will communicate with a number of smaller "sub-stations." The new central stations will be located at Puerto Morelos, Puerto Mexico, Monterey, and Culiacan. Those already in operation or under construction are located at Mexico City, Tampico, Torreon, and Hermosillo.



Map showing operating radio stations in Mexico.

Transmitters of the type described in this article will be installed at the new central stations as follows:

Station	Capacity	Maximum Communication Distance Required
Puerto Morelos	2 kw.	172 miles
Puerto Mexico.......	2 kw.	172 miles
Monterey	2 kw.	202 miles
Culiacan	4 kw.	280 miles

The map shown in Fig. 1 illustrates graphically how completely the proposed system covers the Republic of Mexico.

These transmitters are rated at 2 and 4 kw. respectively, putting that amount of power into the antenna circuit. This point should be remembered in comparing their output with that of spark or arc transmitters, since the latter are almost universally rated in terms of "input" to the transmitter or arc converter.

The vacuum-tube sets are built to operate on any wavelength between 600 and 3000 meters, when used on an antenna having the characteristics specified in the following paragraphs. By means of wave-change switches any one of four predetermined wavelengths may be selected in minimum time.

These sending equipments are designed to operate on an umbrella-type antenna having two distinct sections. The upper section is used to obtain wavelengths from 1200 to 3000 meters. It has approximately the following characteristics:

Fundamental wavelength................	770 meters
Capacity	0.0027 microfarads
Resistance	3.9 ohms at 1500 meters
... ...	2.4 ohms at 3000 meters

The power for operation is to be supplied at 110 to 220 volts, 50 or 60 cycles, single phase, alternating current; and at full load the sets will draw approximately 8 to 12 kw. respectively from the line. Provision is made in the transmitter for compensation for normal changes in supply voltage, i.e., an increase or decrease of 10 per cent above or below normal.

General Electric Review, March, 1923.

ACID FURNACE LININGS

Iron Age, on page 1101 of April 19, has an article by J. M. Quinn entitled "Lining Acid Electric Furnaces." Analyses of various types of refractories, ganister, silica sand, etc., are included. The author touches upon the question of insulating electric furnaces, and discusses the best method of lining, and suggest a cheaper type of lining; he advocates the utilization of high furnace temperatures by patching quickly after the heat has been drawn.

A paper by Jerome Strauss, chief chemist of the United States Naval Gun Factory at Washington, presented before the American Society for Steel Treating is the basis of an article, "Performance of High Speed Cutting Tools," on page 1103. Excellent photo-micrographs of milling cutters, broken in use, lathe tool, over-heated in hardening, lathe tool, under-heated in hardening. A number of valuable facts are recorded:

(a) Cast Co-Cr steel tools containing high proportions of carbon are subject to breakage in cutting medium hard steel, particularly if the cutting conditions are severe. For the conditions used in this test, their performance rating is very low. For the cutting of soft metals at high speed where the maintenance of a razor-like edge is a desirable condition, these tools may find wide application: in their favor are their high carbon content and great hardness. In intricate forms their low hardening temperature is a distinct advantage. The structure of these tools in the hardened state is showed in Fig. 8.

(b) Tool D-1 (Table 1) gave unusually poor results, probably because of the soft spots in this cutter; it is presumed that the heat treatment was non-uniform as a variation of 418 to 652 Brinell was encountered. This is therefore not a fair test of the material.

(c) Forged Co.-Mo.-Cr. steel shows a performance rating closely approaching that of forged W.-Cr.-V. steel (about 89 per cent). However, the results are erratic and often poor after re-grinding, hence when tungsten prices are low there would be no advantage in the adoption of this alloy. It is worthy of note, however, that the best showing in the second group of tests was made by one of these cutters. Also, as indicating the peculiar adaptability of some cutting alloys, in the lathe tests previously referred to, tools made from this same bar had a performance rating of only 53 per cent as compared with that of tungsten steel of composition similar to that of the milling cutters used here.

(d) Cast tools of high-speed steel (Table 2) under the conditions employed were only 52 per cent to 66 per cent as efficient as tools cut from rolled bars of similar composition. Regrinding does not reduce their cutting ability but, strangely enough, great variations in heat treatment produced little change in the results obtained in these tests. This may perhaps be explained by Figs. 1 and 2, from which it will be observed that the microstructure of tool D-1 (Table 1) is modified by annealing only insofar as the matrix is concerned; the dendritic carbide net work is unaffected. Unfortunately these tests have not at this time proceded far enough to give similar data for the steels of Table 2. It is most probable that solution of the major part of this network would greatly increase the performance of these tools. Nevertheless, where intricate tool form and moderate cutting conditions prevail it is believed that tools in the conditions used here deserve serious consideration; lack of necessity for very high quenching heats for development of maximum cutting qualities would be in their favor.

The same magazine, on page 1118, discusses the labor aspect editorially with the conclusion that the English workmen who desire to try America are desirable and welcome, but must come of their own initiative and not earlier than July of this year, as the British quoto of 77,342 for 1922 has already been received.

One million six hundred and forty-five thousand, two hundred and thirty-seven men in 1922 did the work of 2,012,600, indicating greatly improved personal efficiency.

Attention is directed to statements of Mr. Russell Porter, of the New York Times, who covered the W. Z. Fotser trial in Michigan:

"The two principal planks in Foster's trade union program are amalgamation (or industrial unionism) and the organization of a labor party. He believes that the craft unions of the American Federation of Labor should be amalgamated into big, powerful unions, one to each industry. Instead of many unions in a given industry, with conflicting interests and rival leaders, that can be played off against each other. Foster argues that all the labor in an industry should have the same leadership, interests and objects. In the steel industry, for instance, he would have the workers combined in one organization, from the men who dig the coal and iron ore to the men who put the finishing product into transit.

"Under such a system, he argues, their power would be supreme, they could enforce their demands easily, and when the time came, could seize the industry and, co-operating with other industrial unions, supplant the present form of Government with the Soviet form, abolish capitalism and set up the dictatorship of the proletariat."

PRACTICAL IDEAS FROM POWER, PAGES 605-7 OF APRIL 17

A page description of Harrisburg, Pennsylvania's recovery of river anthracite washed down from the mines by the Susquehanna, together with a picture and details of an installation designed for burning successfully this fine, low volatile coal. Measurable savings have been affected by the change from bituminous coal.

A station engineer's ability to meet emergencies is shown by Mr. D. H. Carter's story on page 606, of a hasty repair to a cracked condenser.

The Engineering Experiment Station of the University of Illinois solved an apparently serious boiler condition by radical methods. Caustic embrittlement, resulting from several years' use of deep well water heavily bicarbonate, was overcome by depositing magnesium carbonate on the internal surfaces by the introduction of sulfuric acid into the water. Page 607.

The Ford Motor Company has designed and is building eight 30,000 k.w. turbo-generators for its own use at River Rouge. Such an undertaking is entirely novel for a concern whose product is distinctly different.

The steam generating end of this power development is being doubled by the installation of four more 2650 hp. Ladd boilers, similar to the original unit of four, so widely discussed and analyzed. Powdered coal in combination with blast furnace gas, and occassionally tar from the by-product plant are the fuels used.—Page 593.

UNAFLOW PUMPING ENGINES

The same issue, pages 584-587, describes a replacement of compound engines at the Torresdale Filtration Plant near Philadelphia.

After some 15 years of severe duty, increasing demands for additional water necessitated radical improvements. The problem was to continue operations, replace equipment, save as much existing equipment as possible, not enlarge the buildings, and at the same time, provide for the water demand at lower operating cost.

Single cylinder center-crank Ames Unaflow were assembled in vertical position, direct connected to the pump shaft.

Two of the engines have electric-speed-changing devices, which permit a variation in the pump output, when the plant is working on reduced schedule.

No changes were made in the condensor equipment. Table 1 shows the result of tests conducted by the Philadelphia Water Works, Department engineers.

Copy of test with page 586; monthly unit cost page 587.

TABLE I—DATA AND RESULTS OF TEST

Test of Ames Unaflow engine at Torresdale plant, to determine the water rate. Test conducted by Philadelphia Water Department engineers.

Type of engine	Vertical unaflow
Class of service	Pumping service
Condenser	Surface type
Make of condenser	R. D. Wood
Air pump, type	Steam ejector
Make	Ross Heater Company
Condesate pump	Centrifugal turbine-driven
Make	De Laval
Rated indicated horsepower of engine	500
Builder	Ames Iron Works
Kind of valve	Double-beat poppet
Type of governor	Centrifugal-inertia
Diameter of cylinder, inches	23
Stroke, inches	27
Type of pump	Single-stage centrifugal
Capacity of pump	40M. gal. at 45 ft. head
Make	R .D. Wood
Date of test	May 18, 1921
Duration, hours	4
Pressure in steam pipe at throttle, lb. gage	170.9
Vacuum, inches	25.4
Steam temperature, deg. F.	388.3
Temperature of saturation, deg. F.	375.6
Superheat, deg. F.	12.7
Total condensate, pounds	29.316
Steam consumption per hour, pounds	7.329
Revolutions per minute	173.4
Piston speed per minute, feet	78.03
Indicated horsepower	501.8
Steam consumption per i. hp.-hr.	14.6
Heat units consumed by engine per i. hp.-hr.	16,168.6
Thermal efficiency of engine, per cent	15.7
Steam consumption of Rankine cycle, lb. per i.hp.	8.8
Rankine efficiency of actual engine, per cent	60

UNIT COST

Labor	$ 6,662.92
Material	11,104.47
Total	$17,767.39
Monthly output, million gallons	5,509.3
Daily output, million gallons	177.60
Cost per million gallons	$3.23
Average head, feet	46
Cost per water-horsepower-hour	$0.0167

The results obtained from the six unaflows prompted the Water Department to replace the seventh compound with another Ames unaflow of the same size and type. This unit will be in operation in a few weeks.

DEVELOPMENT OF THE ATOMIC THEORY

"Chemistry and Industry," the English journal of chemistry, on pages 338-342, of April 6th issue, has a most interesting historical summary of "The Structure of the Atom," by H. Stanley Allen, M. A., D. Sc., professor of Natural Philosophy, University of St. Andrews.

In 420 B.C. Democritus stated, "The only existing thing are the atoms and empty space; all else is mere opinion." Boscovich, author of a theory of Natural Philosophy (1763) has been credited with being the father of modern atomic theory, but Bernoulli and Hooke preceeded him.

Dalton early in the 19th century developed the early Greek speculations into the modern hypothesis.

Faraday wrote in 1834, "If we adopt the atomic theory, then the atoms of bodies, which are equivalent to each other in their ordinary chemical action, have equal quantities of electricity naturally associated with them.

Ampere in 1821 imagined the elementary magnets as due to the rotation of light, positive charges about massive negative ones. "The two unlike particles in the condition described constitute an amperian molecular current." J. J. Thompson of Cavendish Laboratory in 1897 termed the negatively electrified unit a "corpuscle" or electron.

Chan Courtois 1862 had already stated that "The properties of the bodies (elements) are the properties of number," and Newlands arranged them in ascending order of their atomic weights according to his "Law of Octaves." "The number of analogous elements, when not consecutive, differ by 7 or some multiple of 7."

Lewis & Langmuir assigned a definite spatial configuration to the electronic system. According to Lewis, chemical compounds may be divided broadly into two types "polar and non-polar."

The X-ray investigations of rock-salt crystals by Sir Wm. Bragg and his son confirmed this.

The modern theory of Quanta is concerned with the mechanics of the atomic system.

Lord Kelvin pictured the positive electricity as distributed uniformly throughout a sphere of atomic radius with the negative electrons scattered inside the sphere.

Professor Nills Bohr boldly discarded the Newtonion laws and substituted a new set of principles now known as the Quantum Theory. In this theory are now reconciled the exchanges between the Kinetic energy of atoms, and radiant energy.

Dr. Aston's findings on "positive rays," using a "mass spectrograph", have confirmed Prouts earlier hypothesis. The fact that the boldest stars contain little but hydrogen, helium and two unknown substances may be of significance. It may signify the building up of complex atoms from the simple elements. If so, the missing half of the cosmic cycle, may have been found.

X-RAY EXAMINATION OF METALS

About two years ago, the author commenced to examine, by means of the X-ray, electrolytically deposited copper. He was then asked to try several samples of steel, and the experience already gained with the Rontgen photos of the pure copper, proved of great assistance.

The inference image depends principally upon the thickness of the test pieces, the section of the pencils of X-rays, and the hardness and spectroscopic spread of the rays. Experience shows that for any given material, there is a certain most suitable thickness at which the inference patches soon appear very sharply defined. This thickness depends upon the permeability of the given metal, which for commercial steel, represents about ¼ mm.

In preparing samples, care should be taken that no structural changes are caused by mechanical treatment. The best way, according to the author, was to saw off pieces about 5 mm. thick from ingots or billets; and fasten them with screws to a wooden lathe chuck. A central circular depression is then slowly drilled out, but heating should be strictly avoided. The smaller the section of the pencil of rays, the clearer are the inference rings and patches. This involves longer exposure, however, and the problem is to strike the happy medium. The pencil used by the author was about 1½ mm. diameter.

A sketch shows the arrangement of the two screens and samples, as well as the position of the photographic plates. Using two pencils of rays has the advantage that two samples may be examined at the same time, in one apparatus. The most important thing is to choose rays of favorable spectroscopic range.

Iron is comparatively hard to penetrate, hence one is inclined to use rays of the greatest penetrating power. This is all right in the absorption process, where it is a question of determining the differences in density of thick pieces of metal, but it does not serve for the present purpose. In this instance, the author suggests the advantageous use of rays of maximum intensity, between 0.5 and 0.4 Angstrom. Rays of less penetrating power necessitates a very lengthy exposure, amounting sometimes to several hours.

Stahl und Eisen, April.

BUSINESS DECLINE DUE SOON, ECONOMIST HINTS

"Industrial Digest" Article Predicts Drop This Summer in Price of Pig Iron, Fundamental Commodity.

Prices of pig iron, one of industry's great basic commodities, are due to start downward this spring or early summer, according to an article in *The Industrial Digest* for April. The magazine points out that the iron and steel industry is an extremely important element of the business of the country, and that it is affected by the same causes which influence industry as a whole.

The prediction is based upon a study of price movements since 1901 by A. G. Wheeler, economist, who, by means of the same statistical materials, successfully predicted the drop in pig iron prices in the early months of 1920. At that time the drop in pig iron was accompaniel by a decline in general business.

According to Mr. Wheeler's records, pig iron prices since 1901 have always moved rythmically up and down in cycles between 38 and 42 months long. The average cycle, the article says, is 40 months long—that is to say, the price usually continues on its upward swing for 20 months, and on a downwarl swing for 20 months more. Mr. Wheeler has made charts of the price fluctuations since 1901, and these charts show that the theoretical cycle has always been followed by the actual quotations.

"The cycle does not reflect temporary price movements, which may and do fluctuate violently at times in direct opposition to the trend," the article says. "Neither does it afford any indication as to the extent of the rise or fall in prices. What it does indicate is that within the period between a high point on the cycle and the succeeding low point the tendency of prices will be downward and that during the succeeding period of the upward swing of the cycle the price tendency will be upward. Furthermore, the cycle cannot be taken as indicating the exact time at which the turn in the market occurs, as the change may fall anywhere between the extremes, 38-42 months, with the chances all in favor of the median and average, 40 months."

The present upward movement of pig iron prices began in September, 1921, the article says. It has been proceeding regularly since that time, with no interruption except for a temporary decline in the last months of 1922, which was a readjustment of the price after the disorderly rise caused by the priority orders of the Interstate Commerce Commission.

"The 20 months period of the present upward swing will end June 1," says the article, "and then a period of downward price tendency will begin, and this period will last until about February, 1925, if the cyclical movement that has obtained for the past 20 years continues. At the minimum period (38 months) the change would occur slightly earlier; on the other hand, on the maximum period (42 months) the downward swing would be delayed for two months, but somewhere within the April-August period it is bound to occur."

The last downward swing, to which the movement scheduled to start this spring or summer will correspond, began about February, 1920, says the writer.

Railway Age for April describes the progress that Cleveland, Ohio, is making toward a solution of its transportation problem.

Cleveland has long been noted for its excellent street car facilities, but its railroad terminals have been neglected.

The photograph above shows very clearly that Cleveland now steps forward among the leading cities in terminal facilities. Following the well defined tendencies shown in New York City, Montreal and other large cities hotel facilities are to be included in the actual railroad terminal building. The Hotel Cleveland forms the right wing of the structure.

CLEVELAND UNION STATION - Now Under Construction
HOTEL CLEVELAND - Now Running

New Cleveland union station.

ITEMS EMPHASIZED BY IRON TRADE REVIEW FOR APRIL 19

STEEL SHORTAGE MORE MARKED

Manufacturing and construction programs more under check through needs of material—Automobile industry pressing for supplies—Railroads push track betterments—New buying quieter but accumulated orders overwhelm mills.

QUIETER IRON MARKET CONTINUES

Buyers generally refrain from making additional purchases, waiting for developments—Furnaces, heavily booked, not pushing sales—Soft spots in prices few—Michigan automobile builder takes 4,500 tons—Middle interest offers basic.

COKE DECLINE CONTINUES

Furnace and foundry grades 25 cents lower—Round tonnage of 48-hour fuel sold at $6.50—Market expected to rebound.

SCRAP PRICES ARE WEAKER

Consumer buying continues limited to small tonnages—Some grades are scarce and in active demand.

STEEL SHORTAGE SEVERE

Unfilled demand for semifinished estimated at 400,000 tons—Sheet bars, billets and slabs command $47 50—Rods at $55.00.

BAR NEEDS ARE PRESSING

Consumers' operations are ruled by extent of steel supplies—Scarcity is critical—New inquiry heavy—Prices are steady.

PLATE DEMAND SUSTAINED

Heavy buying continues in East, principally for supplying Western requirements -- Production increases.

SHEET BOOKINGS DEFERRED

Makers to carry over large tonnage into third quarter—Black tonnage sold at 3.75c, galvanized at 5.00c—Consumption heavy.

SHAPES CONTINUE ACTIVE

Inquiry of Central Railroad of New Jersey for 25,000 tons features market—March bookings show large increase.

CAR ORDERS ARE MODERATE

Railroads place more rails—Unusual demand for track fastenings in Middle West—Street railroads in market for materials.

GERMANS ARE SELLING RUHR STEEL

Hope to escape confiscation of large tonnages of accumulated material by transferring ownership to foreign buyers—American interest reported to have purchased some—European markets soften.

RUHR WAR BOOSTS WORLD'S PRICES

Stoppage of Europe's furnaces while demand grows heavier affects markets everywhere—Germany plans methods to circumvent French blockade — France tightens her grip—Mutual industrial strangulation. Page 1151. By H. Cole Estep.

HEAT CONTROLS IRON STRUCTURE

Carbon, the governing factor in pig iron, is controlled by physical rather than by chemical properties—Metallurgists now accept structure tests—Work of Moissan on carbon in pi giron described. By E. Adamson. Page 1156.

TUNNEL SEGMENTS BIG CONTRACT

The Bethlehem Steel Company at its Lehigh plant are daily turning out approximately 200 tons of completed cast-iron, machined flange surfaced segments for the Hudson Vehicular Tunnel. More than 2¼ miles of cast segments will be required and the total contract involved over 80,000 tons of castings.

Pages 1160-1163 describe and illustrate this operation.

Each ring of the lining is made of 15 separate segments, the total tunnel length of 6,756 feet requiring 5,400 rings. Two weights of segments are used, 3,000 lbs. and 800 lbs.

In the tunnel excavation, the segments of each ring are put in position, and bolted together, machined side against machined flange face, and the rings are also bolted together, the joints being staggered. To accomplish this, the key sebment construction is used with non-radial joints.

The machining of such a tonnage is a most important detail. To accomplish this commercially, a milling machine was designed and built by Bethlehem, which mills two sides of the segments simultaneously. Two traveling heads, each equipped with 48 in. cutter heads, having inserted roughing and finishing tools, complete the sides to size in one cut.

Great care is used in the inspection, as the assembled rings must be absolutely water-tight. Segments forming a ring are kept together for shipment. Two complete rings, weighing about 42 tons, are loaded on a car.

RETARDS MANAGANESE ORE OUTPUT

Russia, with half of world's supply, produces 33,000 tons in 1922, compared with 1,220,000 tons in 1913 — Exports held back through insufficient shipping facilities—Position of the industry described. By Bruno Schapira. Page 114.

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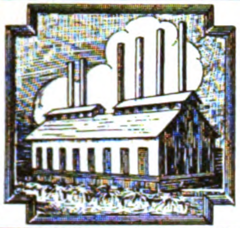
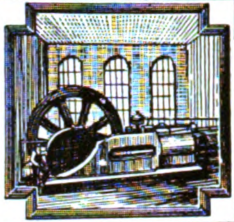


STEAM POWER DEPARTMENT



Graphic Determination of Steam Data and Factors of Evaporation

Graphical Method of Finding Factor of Evaporation and Total Heat When Temperature, Pressure, Superheat and Quality of Steam and Boiler Feed Water Are Given.

By H. C. LINDERMAN*

THE chart shown may be used for determining factors of evaporation and general steam data pertaining to boiler room practice which, of course, does not deal with entropy, without the further aid of steam tables or calculations from the usual formulae. Results obtained during the six months' general use of the chart have been entirely satisfactory and well within the limits of permissible error.

Basis of Chart.

The chart is based on total steam and feed water temperatures on the Fahrenheit scale and has been plotted from Marks and Davis tables of saturated and superheated steam. The feed water temperature lines reflect the specific heats as given in the steam tables and, therefore, preclude the necessity for the usual correction of thermometer readings for heat above 32 deg. F. when obtaining factors of evaporation. In other words, these lines are designated as total feed water temperatures and plotted from the corresponding specific heats for direct determination of factors of evaporation. It will be noted, from chart, that total steam temperature lines have only been carried down to saturation line inasmuch as the relation between pressure and temperature is the same for wet steam as for saturated, since the quality does not affect the temperature.

Saturation Temperature Curve.

The auxiliary saturation temperature curve with scale on right hand margin has been added to facilitate more accurate reading of saturation temperatures than could otherwise be determined without great care in reading up from lower absolute pressure scale to line of dry and saturated steam and approximating the temperature of saturation from relative location with respect to diagonal temperature lines. The pressure and temperature ranges are broad enough to include everything from the small low quality steam heating plant to the latest ecnomizer practice involving high pressure and superheats. Abscissae are absolute pressures and evaporation factors. Ordinates are total heats, Btu. above 32 deg. F. on the left hand scale and saturation temperatures deg. F. on the right hand.

Example No. 1.

Numerous combinations may be worked in solving problems in heat content, factors of evaporation, etc., and the use of the chart may, therefore, best be illustrated by examples.

Example No. 1 as shown on the chart assumes an absolute steam pressure of 275 lbs. with 140 deg. superheat and 205 deg. feed water temperature. It is desired to know the factor of evaporation for these conditions. The chart indicates the dotted line starting at 275 lbs. absolute pressure on the top scale and dropping vertically to the saturation temperature curve from which a line horizontally to the right indicates a steam temperature of 409.6 deg. at saturation, on the right hand scale. By adding to this figure the superheat, a total steam temperature of 549.6 F. is determined. Returning to the point where the dotted pressure line intersects the saturation temperature curve a line is dropped to a point corresponding to the total steam temperature or 549.6 deg. Projecting horizontally to the left hand scale, the total heat may be determined if desired, which is 1286.3 Btu. To determine the factor of evaporation, however, the heat content of the steam need not be read but, instead, the horizontal line is stopped at the oblique 205 deg. feed water and then continued up vertically where 1.1473 is determined as the factor of evaporation for the conditions considered.

Example No. 2.

Example No. 2 assumes absolute steam pressure of 275 lbs. with no superheat. Without further data, it is desired to know the total heat content of the steam at this pressure.

CHARTS ARE SHOWN ON FOLLOWING DOUBLE-PAGE.

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*Assistant to District Stoker Engineer, Pittsburgh Service Department, Westinghouse Electric & Mfg. Company.

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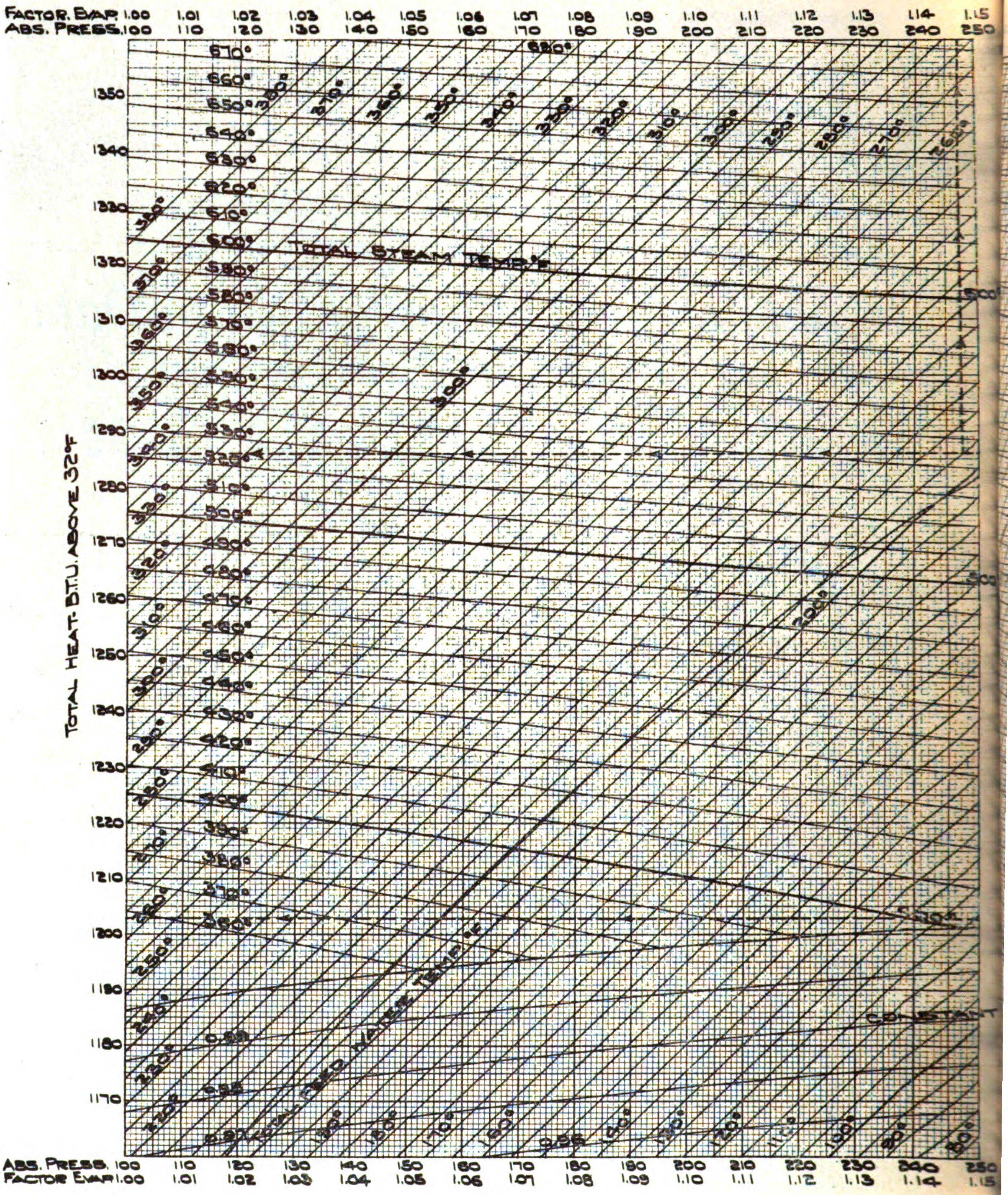
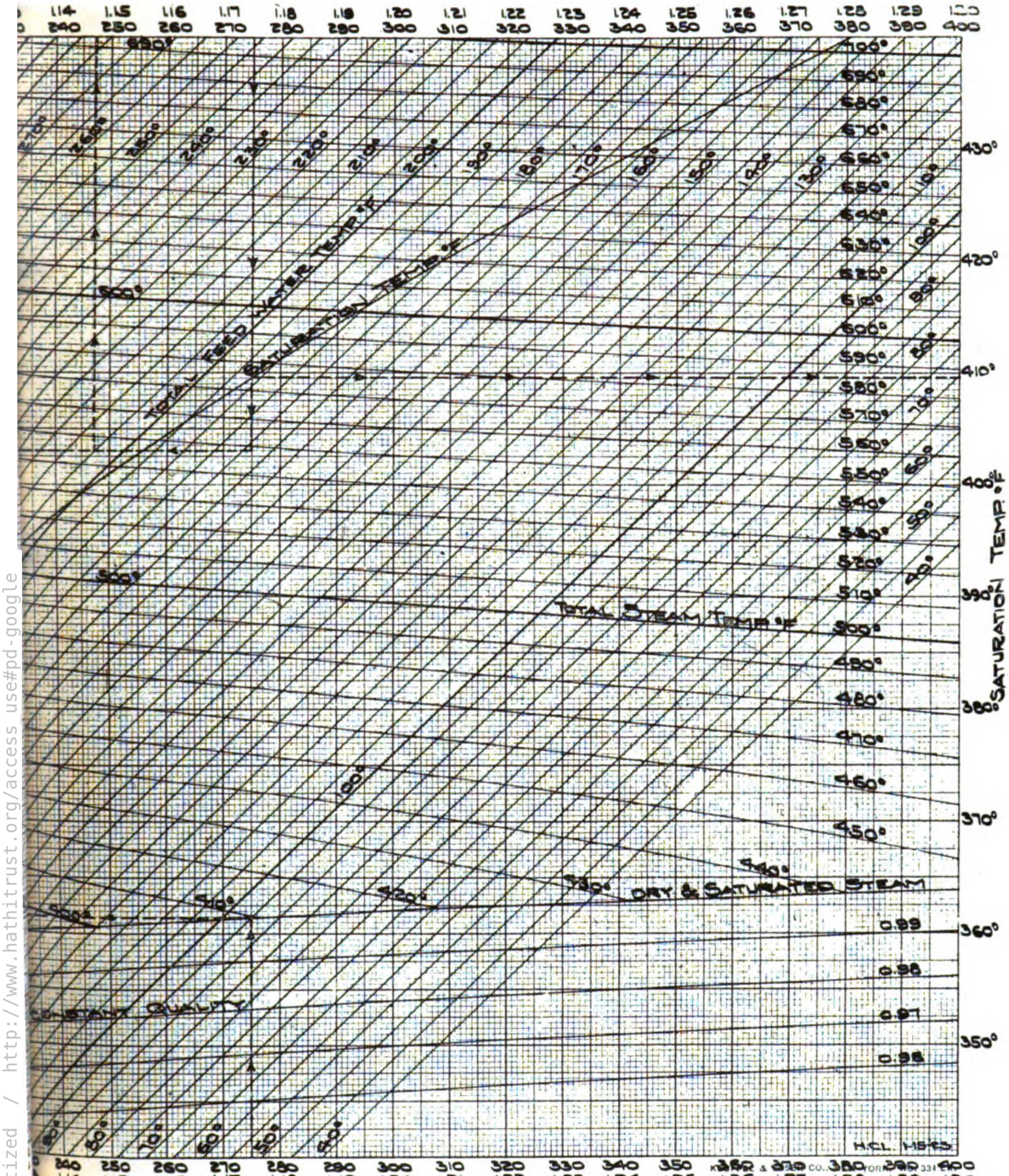


A composite chart for determining factors of evaporation and general

As exemplified on chart, start at 275 lbs. on the lower absolute pressure scale and follow up to the saturation line. From this intersection continue horizontally to the left hand scale where 1202.9 Btu. is determined as the total heat above 32 deg. F. at this pressure.

Example No. 3.

Example No. 3 assumes an absolute pressure of 140 lbs., .98 quality steam, and 170 deg. feed water temperature. Determine total heat in steam and factor of evaporation. On bottom absolute pressure scale find 140 lbs.



am data without further aid of calculations from the usual formulae.

Read up to .98 quality line and left horizontally to total heat content of 1174 Btu. Return to point of intersection of .98 quality and 140 lb. pressure lines and continue right horizontally to the 170 deg. feed water temperature line, then down to factor scale where 1.0677 is determined as the factor of evaporation for these conditions.

Flexibility of Curve.

A fair working knowledge of the chart may be obtained from the foregoing examples. It then rests with the individual, in his ability and ingenuity in applying the various combinations in the solution of problems, to demonstrate further its flexibility and worth.

Mechanical Features of Automatic Skip Hoists

Fundamental Factors Which Recommend Mechanical Hoists for Coal, Coke, Ash, Etc.—Automatic Loaders a Very Desirable Feature—Safety Features Emphasized.

By WM. E. HALE*

IN the February issue of this magazine Mr. Stevens, Engineer of Cutler-Hammer Company, explained the electrical control required for Automatic Skip Hoists. The purpose of this article is to consider the mechanical requirements of a successful skip hoist, together with its control and other appurtenances.

The increasing popularity of the skip hoist for handling not only coal, coke and ashes, but all bulk materials is due to these fundamental facts.

1. Skip hoists have been made entirely automatic, i.e. the bucket loads, ascends, discharges, the hoist reverses and the bucket lowers and reloads, repeating the cycle continuously and entirely automatically.
2. The simplicity of the skip. A bucket, steel cable and winding machine comprise all the moving parts. These are large and not easily worn out and cannot be seriously wrecked.
3. High lift does not add stress in a skip hoist as in the case of chain and bucket elevators or belt conveyors.
4. The path of the skip may be vertical, using minimum space or it may be inclined to save horizontal transporting of the material handled.
5. The bucket is the only part of the skip hoist coming into contact with the material and it can be replaced at small cost when finally worn out. The winding machine which is the only mechanical part of the equipment is located in a remote position free from dust and dirt.
6. As the skip runs only while doing work its power consumption is at a minimum.
7. Repairs and renewals are such that they can be readily made at the plant, eliminating the necessity of carrying an expensive stock of special replacement parts.

The Skip Bucket.

The bucket should be so designed that it can be lifted above its normal dumping position without damage to itself, or the structure. Care must be taken with the turn over type that bucket cannot invert entirely when in such position as otherwise it would probably jam when it is lowered again.

Provision should be made on the bucket for easily taking care of the adjustment of the cable length. Also the bale should be so attached to bucket or other provision made so that the rope need not be taken up until after the rope has stretched eight or 12 inches.

The turn over type bucket seems to be much more popular than the bottom dump type. It starts to dump before reaching the final limit and may continue to dump while being lowered. With the bottom dump type, plenty of time must be given for material to get

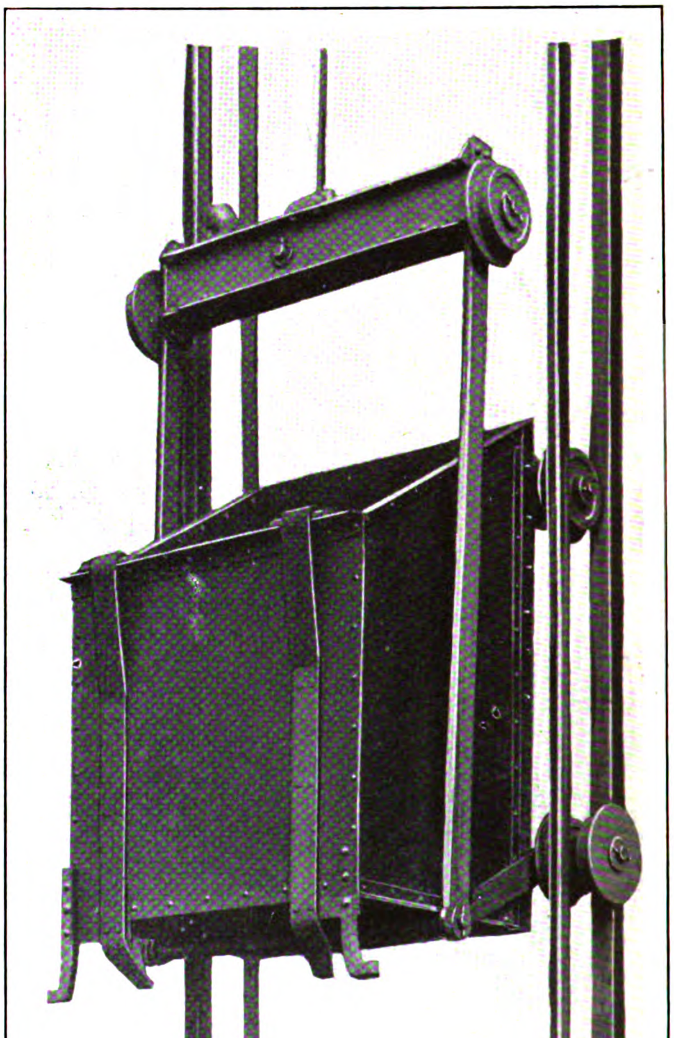


FIG. 1—*Hoist bucket in vertical position.*

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*Chief Engineer, R. H. Beaumont Co., Philadelphia, Pa.

through the opening, as lowering with material in the bucket would probably distort the gate or door. The opening also must be made large so that lumps cannot jam.

Most skip buckets are simple rectangular boxes, open at the top and fitted with flanged wheels and hoist bale. They are usually discharged by inverting on dump rails. Bucket is generally made of steel plate stiffened with angles, but may be made of wood, monel metal, or any substance to suit the characteristics of the material handled.

A square steel shaft journalled for the wheels is the most common type of axle. Wheels are usually cast iron wit ha chilled tread. Some type of lubrication must be provided for the wheels that does not require frequent attention. The hollow wheel filled with oily waste is one of the best types. The forward axle may be fitted with relief springs to reduce the shock when bucket engages the dump rails.

The hoisting bale may be constructed of heavy flats, angles, or channels for the side members with a cross beam at the top for the attachment of cable. The lower end is usually attached to a shaft similar to that used for the wheels.

Counterweights, Cable and Fittings.

Where possible the counterweights should travel vertically. In cases where it is necessary to build a special counterweight carriage fitted with wheels to carry the counterweight. The accepted type of counterweight is of the triple compensating type. The purpose of this triple compensating counterweight is to reduce the amount of counterweight at the time when the weight of bucket is reduced due to it running out on the dump rails and discharging its load. When a compensating counterweight is not used, the excess of counterweight when bucket is on the dump rails would tend to increase the speed of the bucket just when it should be reduced. The compensating counterweight also gives easier starting conditions when bucket starts downward as there is practically no load on the motor. The total amount of counterweight should be such that the load on the motor is approximately the same when lowering as when hoisting.

Rope for counterweight should be the same size and type as the skip bucket hoisting rope.

The hoisting and counterweight cables are usually improved plough steel wire rope, with hemp center and composed of eight strands with 19 wires to each. This cable has proven to have just the proper degree of flexibility yet the individual wires are not too fine to resist wear.

Swivel blocks are often used at the head on small skips but all skips larger than 40 cu. ft. should use sheaves. Large sheaves of the bicycle type are used. The sheaves should be keyed to stud shafts revolving in two bearings.

Winding Machines.

There are three types of winding machines in use on automatic skip hoists. First, the traction hoist, second the worm geared freight elevator hoist, and third the high speed cut spur gear winding machine.

The traction type winding machine, while apparently the simplest machine is controlled by limit switches set in the track runway. These switches may be put out of order by weather conditions or knocked off by a piece of stray material. A traction type machine presupposes that the cable will slip through the traction wheels when either the counterweight is bottomed, but as the hoist is generally located at the top of the skip runway the weight of the cable suspended from the drums on the side where the counterweight is bottomed is enough to give considerable traction, possibly enough to actually hoist the emptied bucket above the upper limit.

The worm geared type of winding machine, even with worm drive running in oil is only 50 per cent efficient, while with cut spur gears operating in oil efficiencies of 85 per cent and higher are readily obtained. This inefficiency of the worm drive causes much waste power. The feature of a worm drive is that it is self-locking, i.e. the hoist cannot run away because the worm will hold it, but a self-locking worm is so inefficient and the wear on the worm, worm wheel and thrust bearing and the excessive heat generation is such that this hoist has been generally abandoned in favor of the spur geared type.

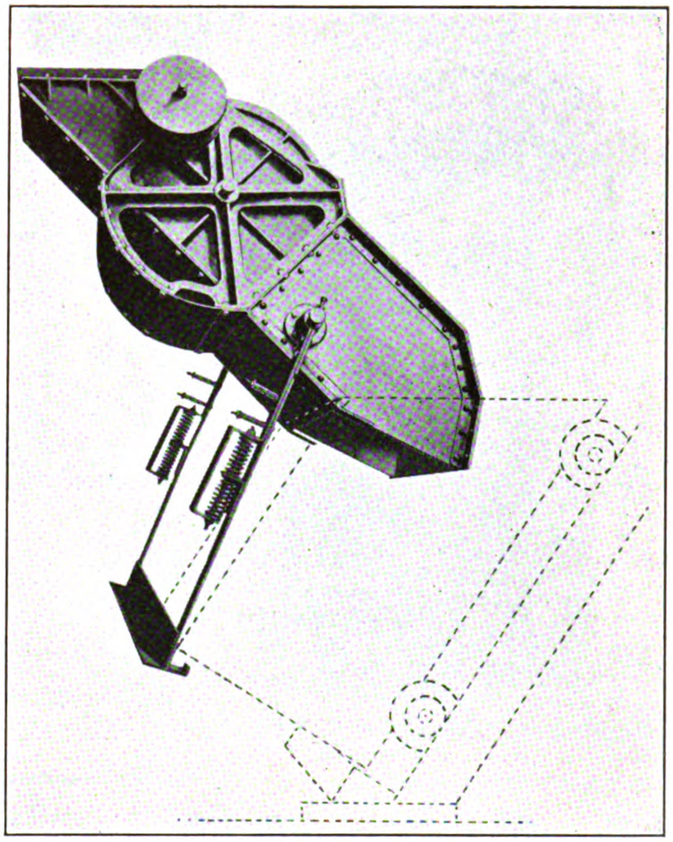


FIG. 2—*Automatic loader.*

The latest type skip hoist winding machines have hoisting drums with machine turned grooves, cut spur gears running in oil in a fully enclosed housing, bearings cast integral with the frame and lubricated by oil cups.

On the smaller types of winding machines the gear housing may be cast iron split at the bearings, the bearings being built into the upper and lower part of this housing. On larger machines the upper portion of the housing is better if made of steel plate to avoid excessive weight, and the bearings have separate caps.

Skip hoist winding machines of this type have been built to hoist up to 450 tons of coal per hour at a lift of 100 feet.

Automatic Loaders.

The purpose of an automatic skip bucket loader is to eliminate an attendant. It loads the bucket automatically, the skip hoist will therefore work at its maximum capacity because there is no delay in loading and because bucket is filled at each loading.

There are four general types of skip loaders. First, the measuring type; second, the weighing type; third, the time interval type; and fourth, the damming type.

The measuring type consists of a hopper holding exactly a skip bucket full with a gate above and a gate below. With he upper gate open and the lower gate closed this hopper fills up. When the skip bucket comes down it opens the lower gate and closes the upper one, letting the hopper full of coal into the skip bucket. The skip bucket when going up, closes the lower gate and opens the upper gate. This type has the disadvantage of requiring a very deep pit.

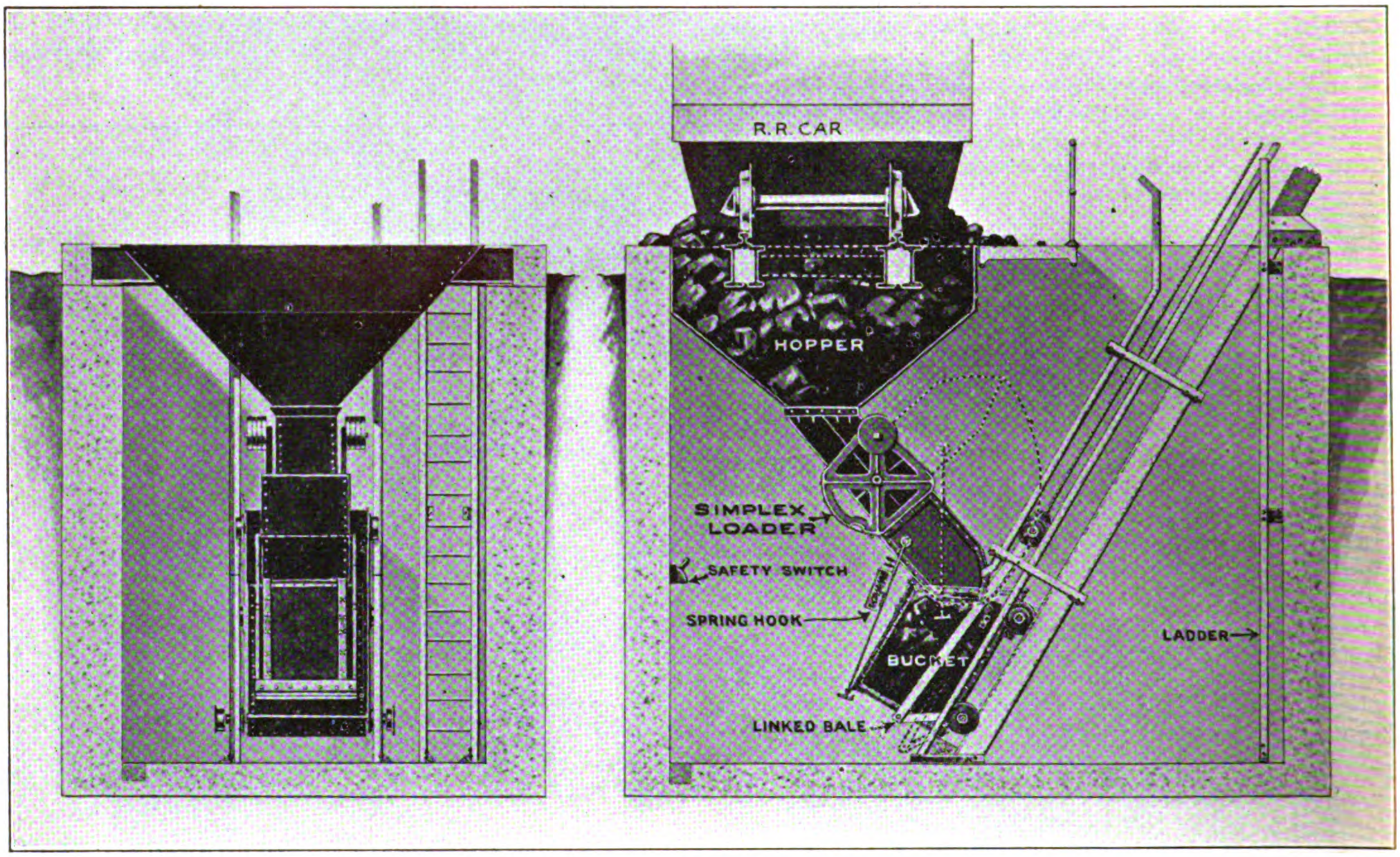


FIG. 3—*Automatic loader shown in relation to hoist pit.*

The weighing type consists of a gate opened by the skip bucket and a scale mechanism which is electrically connected with the control panel and into which bucket descends. When a predetermined weight is in the bucket an electrical contact is made which will start skip bucket up. This type is rather delicate in its parts and can easily be put out of adjustment.

The time interval type consists of a gate opened by the bucket and an air or oil dashpot on the control panel which is so set to start bucket up when a certain time has elapsed, during which time the bucket is supposed to fill properly. This type is successful only when the material handled is consistently uniform in size and condition.

The damming type consists only of a gate opened by the bucket and so made that it dams itself up when bucket is full. See Fig. 3. The load always fills the bucket properly

Automatic loaders should be so made that if the bucket should accidentally fall no harm can result to the loader. The engagement of the bucket with the loader should be cushioned by springs or a combination of friction draft with springs to prevent undue shock. All parts should be strong and rugged. The loader should be made to properly handle all material that may come o it, such as both run-of-mine bituminous coal and buckwheat anthracite. It should be counterweighted in such a manner that no undue load is thrown on motor from the closing of the loader gate.

Speeds and Control.

The usual speeds of skip hoists are slow speed (75 feet per minute) medium speed (125 feet per minute) and high speed (250 feet per minute). The high speed skip should slow down to about half speed at the upper and lower terminals.

The slow speed skip is used principally for ash handling service or small quantity foundry refuse handling. The medium and high speed skips are used for coal, coke, ashes, ore, limestone, or any bulk materials which must be handled in large capacities.

Controls for skip hoists divid themselves into two general classifications—semi-magnetic and full magnetic control. The semi-magnetic type is used when no slow down is required. It reduces the number of magnetic switches necessary with slow down. An important feature of this control is that it cuts the main line circuit in case the pilot circuits fail to stop the motor. A geared flyer controls the length of the skip bucket travel. It consists of a cast iron frame supporting a screw driven by cut gears from the winding machine. On this screw a cam travels horizontally between two rotating cams, keyed to the screw at intervals which are determined by the bucket travel. The traveling cam engages either rotating cam, thereby rotating a frame or "flyer" which, by means of cut gears, turns the drum switch which reverses the motor.

For 75 feet per minute a.c. skips using squirrel cage motors with high-resistance rotors, control panel usually consists of a single wall-mounted slate, containing a magnetic main line contactor and inverse time limit overload relay. Slip ring motors when used require, in addition, a time limit automatic starter with oil dashpot.

For 75 feet per minute d.c. skips, control panel consists of a single wall-mounted slate, containing a magnetic main line contactor, a time limit automatic starter with oil dashpot, a double coil overload relay and a brake relay.

For 125 feet per minute skips, or in all cases where the skip bucket is loaded automatically, a control relay and timing relay is added.

The full magnetic control is best accomplished by the use of a traveling limit switch. This device is actuated by cut steel gears from the winding machine countershaft. It makes the proper control connections for reversing the motor at the top and bottom limits of the skip and also for acceleration and deceleration. It consists of a nut traveling along a threaded shaft, the length of travel corresponding with the lift of the skip bucket. At the limits, the traveling nut rips out double pole switches, which reverses the hoist. Two extra switches are located on the shaft for slowing down the skip.

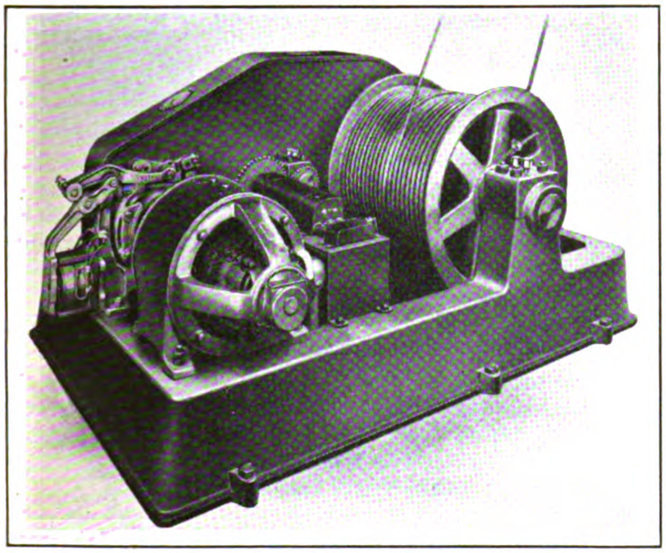


FIG. 4—*Spur-geared winding machine.*

A d.c. full magneic panel consists of a series of slates bolted on a floor mounted angle iron frame, with resistance self-contained. Panel has main service switch and control fuses and inverse time limit overload protection. Acceleration for high and low speed motor circuit is of the positive time limit principle with all contactors the same size throughout and provided with magnetic blowouts in the primary circuit.

The interval for loading and dumping is provded for by a positive time limit overload relay of the same size and type as the accelerating relay.

A d.c. fullmagnetic panel consists of a series of slates bolted on a floor mounted steel and pipe frame. On the top of the panel is mounted a double coil time limit overload relay, pilot fuses, two sets of double pole reversing contactors, which are both mechanically an delectrically interlocked, and one spring closed armature shunt slow down contactor. Bottom row—one control relay, one set of series relay accelerating contactors complete with magnetic blowouts, all progressively interlocked, and one timing interval relay.

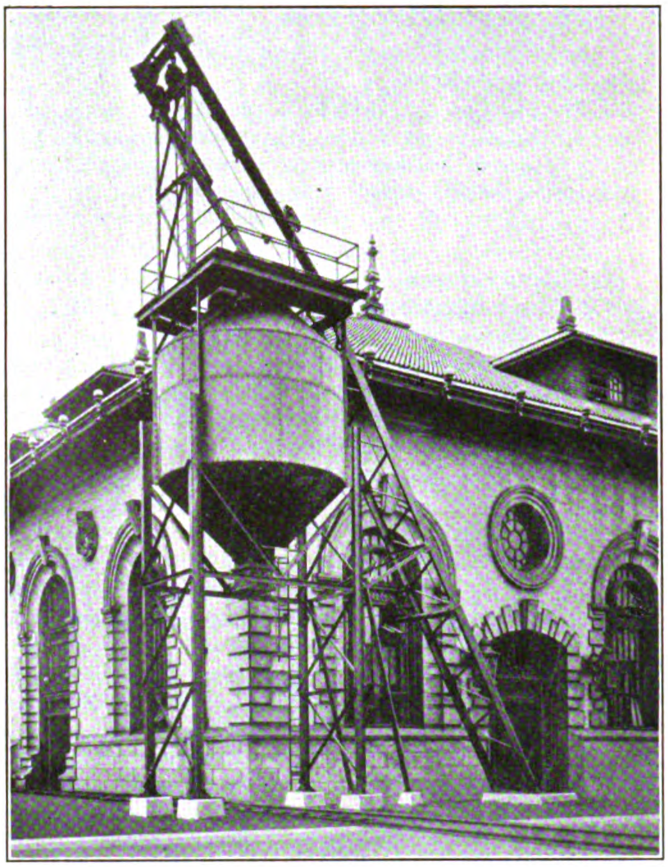


FIG. 5—*Outside ash bin and skip hoist.*

Time limit acceleration must be used on all skip hoists with automatic loaders to insure that bucket under all conditions of loading, will have closed the loader before the speed is increased.

Safety Features.

The modern automatic skpi hoist is equipped with the following safety appliances and features:

1. A magnetic brake is applied to the extended motor shaft on the winding machine. This device will hold the bucket at any point in its travel in case of accidental current failure.

2. Slack cable switch at the hoist drum, which will stop the skip hoist instantly if the cable should become slack from any cause.

3. Track limit safety switches are provided at the top of the bucket travel and at the top and bottom of the counterweight travel. These switches will stop the skip hoist should the bucket or count-

erweight travel beyond their designed stopping point.

4. Safety protection switches are placed at the top and bottom of the skip bucket runway so that the workman can cut off the current while working at these points.

5. Adjustable cable take-up on all counterweighted and balanced skips.

6. Automatic cable take-up on all automatically loaded buckets.

7. Mechanical interlock on single skips used for both coal and ashes, which prevents coal getting into ash bunker and vice-versa, and electrical overflow switch which stops the skip in case of an excess amount of coal piling into discharge hopper.

8. Overload and no-voltage release relays in the electrical control will stop the skip hoist in case of an excessive overload or of the failure of current.

9. Movement of bucket is controlled by a positive mechanism geared direct to the winding machine and is not controlled by exposed switches in the skip runway.

10. On medium and high-speed skips the forward axle of the bucket is equipped with spring relief bearings to reduce the shock when bucket engages with dump rails on overhaul.

11. Provision is made so that it is impossible for the skip bucket to return upside down after discharging.

12. A space of two feet is provided between the uppermost travel of bucket and the head blocks. This allows for any accidental overhaul of the bucket.

13. On high speed skips absolute protection against runway is obtained by the use of two-speed motors on a.c. and by dynamic braking on d.c.

PENNSYLVANIA RAILROAD BUYS FOURTH 20,000 KV-A. TURBINE GENERATOR FOR LONG ISLAND POWER HOUSE

The Pennsylvania Railroad has recently purchased from the Westinghouse Electric & Manufacturing Company a 20,000 kv-a. turbine generator, complete with condensers, auxiliaries, and switching equipment for installation in its Long Island City Power House, which supplies power to the Pennsylvania Tunnel and Terminal Electrification at New York. This is the fourth unit of this capacity that the Pennsylvania Railroad has purchased from the Westinghouse Company for this power house, the capacity of which is being greatly increased.

The Long Island City Power House, as originally installed, had a capacity of 38,000 kv-a., the equipment consisting of four 5,500 kva-a. turbine generators and two 8,000 kv-a. turbine generators. Previous to this last orde rthree of the 5,500 kv-a. machines had been replaced with three of 20,000 kv a. capacity, the last of which has just been installed and put in operation. The machine now on order will replace one of 5,500 kv-a. and one of 8000 kv-a. capacity. The station will then contain four 20,000 kv-a. turbines and one of the original 8000 kv-a. units and will have a total capacity of 88,000 kv-a. as compared with the original capacity of 38,000 kv-a. It is the intention of the railroad to eventually replace the remaining 8000 kv-a. unit with another 20,000 kv-a. machine, making the final capacity of the station 100,000 kv-a.

Each of he four 20,000 kv-a. installations consists of one 20,000 kv-a. high pressure condensing steam turbine generator. 11,000 volts, 25 cycles, three phase or for 13,000 kv-a. single phase operation; one 32,000 square foot surface condenser; one direct turbine driven Le Blanc air pump; one motor driven condensate pump; one turbine and gear driven circulating water pump; and the necessary switching equipment for controlling the apparatus.

The Department of Commerce announces the sales of mechanical stokers

Month	Number of establishments reporting.	Number of stokers sold.	Total horsepower of stokers sold.
January	15	145	83,270
February	15	(1) 129	66,619
March...........	15	(2) 120	68,955

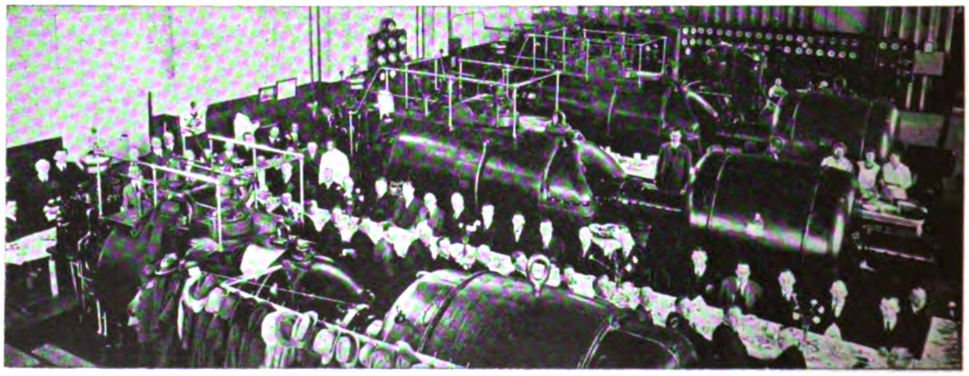
ROTARIANS FETED IN POWER HOUSE

A unique setting was arranged for a banquet tendered the members of the Rotary Club of Boulder, Colorado, recently the Western Light and Power Company, one of the largest central stations in the West.

The event was held in the power house of the Light and Power Company at Lafayette, Colorado, near Denver, the banquet tables being set between two large Westinghouse turbines and covers being laid for 75 Rotarians.

Three Westinghouse Type M-2 electric ranges were used to cook the food, which included 67 pounds of ham. The menu consisted of grapefruit compote, olives, celery, pickles, baked ham, candied sweet potatoes, frittered corn, potato salad, baking powder biscuits, head lettuce, Thousand Island dressing, pumpkin pie and coffee and cigars and cigarets.

Arrangements for the banquet were made by E. B. Ball, commercial manager of the Western Light and Power Company, and M. E. Lanning, heating appliance specialist of the Denver office of the Westinghouse Electric and Manufacturing Company.

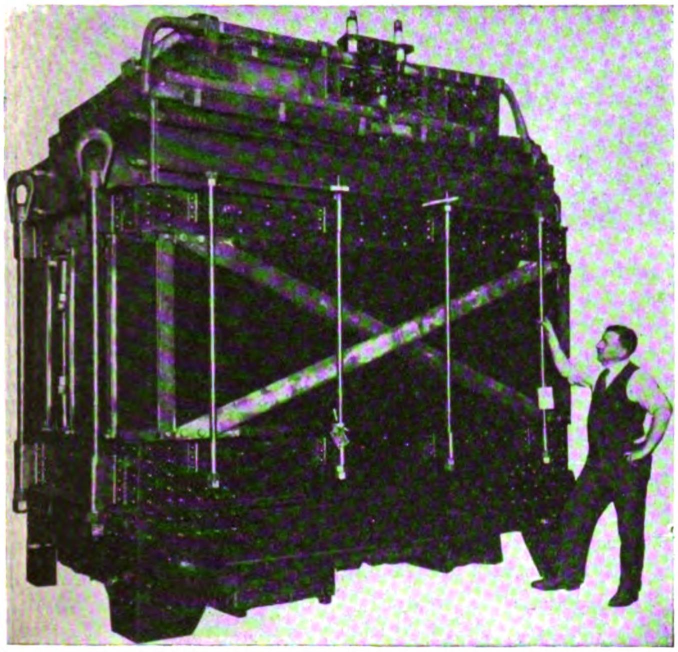


The Rotarian power house luncheon.

WITH THE EQUIPMENT MANUFACTURERS

The Westinghouse Electric & Manufacturing Company has just completed for the Southern California Edison Company six of the largest single-phase auto-transformers ever built.

The transformers are of the water-cooled type and are for outdoor service in the Eagle Rock substation of the company, to form a part of the largest 220,000 volt power system in existence. Each unit is rated at 36,700 kva, 50 cycles, giving a bank capacity of over 100,000 kva., and is adapted for star-star connection with solidly grounded neutral, stepping down from 220,000 to 150,000 line voltages. A tertiary winding, conected in delta, is supplied for suppressing third harmonics in the voltage wave. The transformers are of the shell type and are designed to withstand without injury mechanical stresses due to short circuits when unlimited power is supplied at the terminals. The tested efficiency was over 99 per cent.



The new transformers are to be used for changing the voltage of the two 150,000 volt lines now running between the Big Creek Stations and the Eagle Rock substation to 220,000 volts. At present, the city of Los Angeles is supplied with power through the Eagle Rock substation, the power being transmitted to Eagle Rock over two 50 cycle transmission lines from the great hydraulic development on the Kern River. These transmission lines are now operated at 150,000 volts, but the growth of the hydraulic development has made it necessary to change them to 220,000 volts in order to economically carry the increased amount of power.

The Eagle Rock substation is designed for 150,000 volt incoming transmission lines, and, to avoid making changes in the substation, the new auto-transformers will be used to step down the 220,000 volts to 150,000 volts. The units are to be connected as an integral part of the 220,000 volt line, there being no circuit breakers in the high voltage side. All the switching and metering will be done as before on the 150,000 side of the substation.

In addition to being the largest auto-transformers ever built, these units are also the largest units in existence for stepping down from a 220,000 volt line. An idea of their size will be given by the following figures: The tank, which has flat sides and half round ends, is 10 ft. 3 in. wide and 14 ft. 3 in. long. It is approximately 15 ft. high, and, in order that it may be shipped, the side walls are divided near the middle so that the top portion can be lifted off. The height from the ground to the tip of the condenser bushings is about 27 ft.

NEW GONDOLA CAR DUMPER

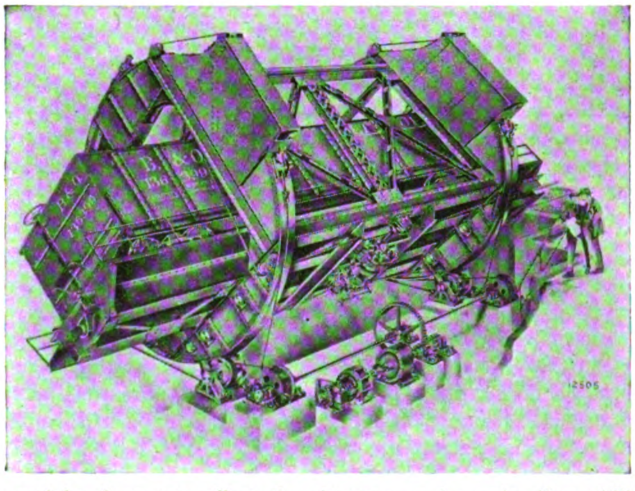
A new gondola car unloader, recently designed and built by the Link-Belt Company of Chicago, contains a number of interesting features.

It is usually supposed that a cradle sufficiently large to support and rotate a freight car must necessarily be large and powerful, yet so simple and well balanced is the equipment that it is not only very reasonable in size, but it can be operated by anyone, however skilled. It requires but 35 to 45 hp. to operate and is capable of handling 40 cars an hour.

The accompanying illustration shows the simplicity of construction and general function of the unloader.

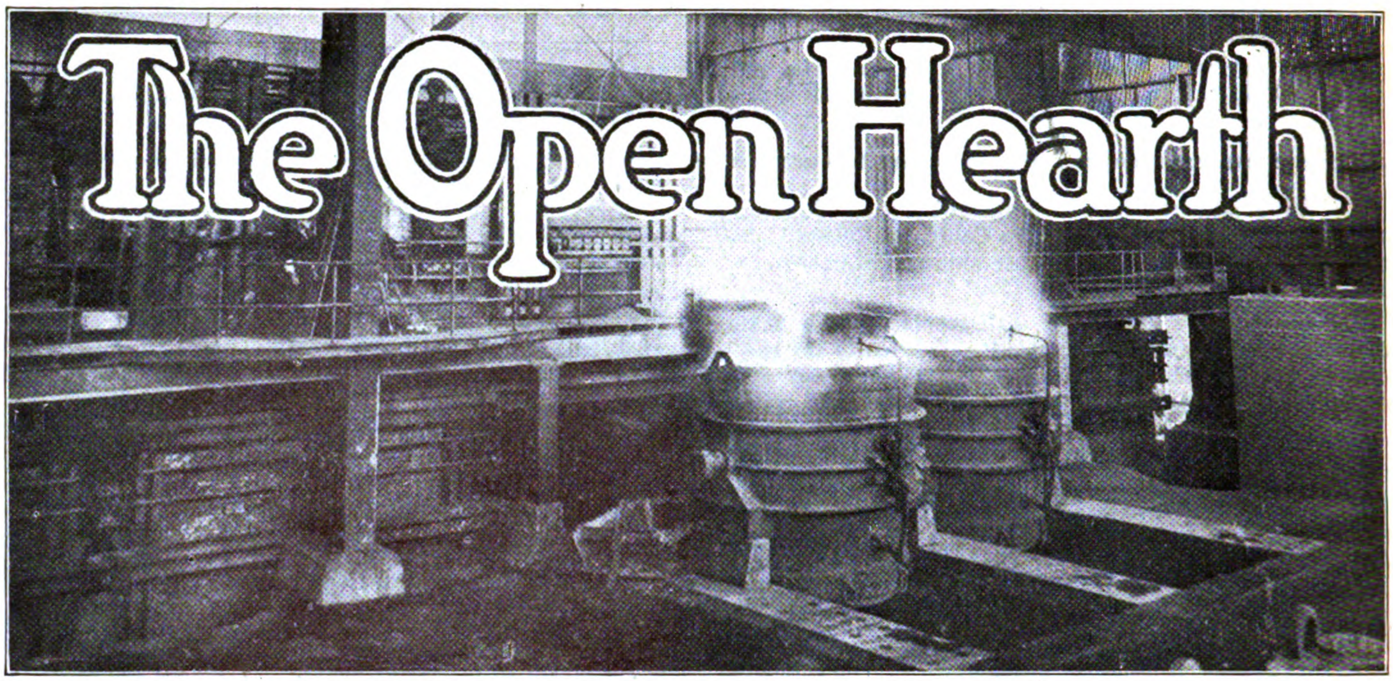
When unloading a car of coal or other material and the machine started to operate, the car is supported by a long, fixed platen upon which the entire side of the gondola rests when being rotated. At the same time, and operated by a time-switch, the top clamps descend and hold the car on the rails by an absolutely equalized pressure at all four points. The dumper then turns over, discharges its contents into a pit or hopper below, returns to an upright position and automatically releases the car, thus making it ready to be pushed off the dumper for the successive car.

Any gondola car of standard design can be unloaded with this car unloader. Variation in length, width, height, capacity or weight does not affect the dumper or its unloading ability. So well balanced is the whole mechanism that there is no necessity for "spotting the car" in any exact spot.



For operation, nothing is required except the movement of a lever similar to the control lever on a street car. Owing to this, the most unskilled labor can be employed as operator.

The new dumper will soon be installed for a large firm in East St. Louis, Ill.



The Open Hearth

J. P. Warren has been re-elected president of the Penn Seaboard Steel Corporation, Philadelphia. C. F. Jemison was elected vice president and treasurer and M. S. Hager, secretary and assistant treasurer; W. P. Barba has become chairman of directors. Mr. Jemison, who remains as treasurer, succeeds George Satterthwaite, who recently resigned as vice president.

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Elbert H. Gary, chairman of the United States Steel Corporation, returned April 13 on the Mauretania from a 67-day cruise of the Mediterranean.

√ √

Charles A. Mead, chief engineer of the division of bridges and grade crossings, board of public utility commissioners, Newark, N. J., has been appointed a representative of the American Society of Civil Engineers on the American Engineering Standards Committee, succeeding Martin Schreiber.

√ √

M. D. Curran has been appointed assistant general superintendent of the St. Louis Coke & Chemical Company, St. Louis, and E. L. Clair has been made superintendent of blast furnaces, according to an announcement by George A. Morrisey, general superintendent of the company. Mr. Curran formerly was assistant general superintendent and Mr. Clair superintendent of blast furnaces for the Toledo Furnace Company, Toledo, Ohio.

√ √

M. M. Marcus has resigned as vice president and general superintendent of the Rhode Island Malleable Iron Works to become associated with the Gulick-Henderson Company, New York, engineers, metallurgists and chemists. He will be connected with the company in the capacity of consulting engineer in charge of the foundry department. His entire time will be devoted to consulting foundry engineering. He will continue to serve on the committee of molding sand research and the sub-committee on conservation and reclamation of molding and core sand of the National Research Council.

√ √

John F. Lewis, who has succeeded Harry Hyatt as general superintendent of the Lakeside works of the Otis Steel Company, Cleveland, now is completing 24 years of service in the iron and steel industry. Shortly after graduating from Massachusetts Institute of Technology, he entered the laboratory of the Duquesne works of the Carnegie Steel Company in 1899. From this position he advanced until several years later he was placed in charge of the open hearth department in Duquesne Some time later he resigned to become connected with the American Steel & Wire Company at the Donora works, where he was in charge of open hearths. Later he was transferred to the Newburgh works at Cleveland, where he remained until December 15 of last year, when he was named general superintendent of the Schoenberger works of the company. This position he held until April 1 of this year, when he resigned to accept his present position with the Otis company. Mr. Hyatt has resigned his connection with the company. For the present he will take a much needed rest.

John Killion has resigned as superintendent of the Whiting Chain Company, North Attleboro, Mass., to go with the Automatic Chain Company, Providence, R. I. He was presented with a purse of gold by the employes previous to leaving.

√ √

E. P. Everhard, for the past six years mill engineer for the Weirton Steel Company, Weirton, W. Va., has been appointed assistant to the vice president of Freyn, Brassert & Company, Chicago. Prior to his connection with the Weirton company, Mr. Everhard was with the Can Sheet Steel Company, the Timken Roller Bearing Company, and the Central Steel Company.

√ √

Charles R. Peebles has resigned as general superintendent of the Ashland, Ky., division of the American Rolling Mill Company, Middletown, Ohio. Before the Ashland Iron & Mining Company properties at Ashland were taken over by the American Rolling Mill Company, Mr. Peebles occupied the position of manager of the blast furnace department.

√ √

The Hyatt Roller Bearing Company, Newark, N. J., reports increased activity on open hearth equipment, particularly on ingot mold and charging box cars. During the first quarter of 1923 the Hyatt Roller Bearing Company has supplied the improved type of Hyatt bearing to equip 300 open hearth cars, in 11 steel plants throughout the country. The Hyatt type of steel mill bearing is also to be supplied on the hot beds of the Timken Roller Bearing Company's bar mill at Canton, Ohio. Carnegie Steel Company, Homestead Works, have contracted for Hyatt steel mill type bearings to completely equip the two tilting tables for the 140-inch plate mill.

Some Pointers on By-Product Coke Oven Operations

DESULPHURIZATION OF COKE BY STEAM

In the course of laboratory experiments in the desulphurization of coke by steam, being conducted by the Department of the Interior at the Pittsburgh, Pa., experiment station of the Bureau of Mines, steam tests at atmospheric pressure for the removal of sulphur from chunk size coke have been finished, with encouraging results. Combined sulphur as FeS. $FeSO_4$ and free sulphur (not including solid solution sulphur) in Ohio coke was reduced from 1.38 to 0.72 per cent. The solid solution sulphur was not affected, but it has been shown that this has very little effect in contaminating sponge iron in the blast furnace. In Illinois coke, 0.62 per cent sulphur corresponding was reduced to 0.48. Clairton coke low in sulphur was reduced from 0.29 to 0.17 per cent. Sulphur in a sample of gas-house coke from Philadelphia was reduced from 0.81 per cent to 0.60. These results were obtained without application of vacuum which may reduce still further the amount of sulphur. Very little steam is required—three grams of steam per gram of coke per hour were employed, which is a big excess. Iron will be heated in contact with the treated coke and the transfer of sulphur determined.

LOW TEMPERATURE CARBONIZATION OF PITTSBURGH STEAM COAL

In the course of experiments in the low temperature carbonization of coal from the Pittsburgh seam, being conducted by the Department of the Interior at the Pittsburgh, Pa., experiment station of the Bureau of Mines, the following results have been obtained:

	Yields	
	Tar, Gal. per ton of coal	*Gas, cu. ft. per ton*
Regular seam	35	3,300
Lower ply roof	24.6	2,500
Upper ply roof	22.3	2,150
Rooster	25.0	2,650

The coke in all parts is good, hard and dense. In general, the figures for yields and quality of products from the Freeport seam apply also to the Pittsburgh seam. Kittanning coal was run for comparison and gave a low yield of oil per ton of coal. The coke was soft, brittle and non-caked. Five gallons of oil per ton of the coal was obtained.

The Bureau of Mines, Department of the Interior, has just issued the report of their lignite carbonizing experiments conducted at Grand Forks during 1922, serial No. 2441. The complete report covers 26 bulletin pages, and contains many useful charts, tables and diagrams.

The Trumbull-Cliffs Furnace Company, Warren, Ohio, has disposed of a bond issue of $3,000,000, the proceeds to be used for extensions in its plant. The bulk of the work will consist of a battery of 47 by-product coke ovens, with auxiliary machinery. William G. Mather is president.

The Bethlehem Steel Company, Bethlehem, Pa., has a total of seven blast furnaces in operation at its Lackawanna mills at Buffalo, N. Y., giving employment to a total force of about 8,500 men in all branches of the plant. It is expected to blow in two additional stacks in the near future and work is now in progress for necessary repairs and relining. The plant is running on a basis of slightly better than 85 per cent of normal, and will be advanced to 100 per cent as soon as the equipment is ready. Present bookings insure full operations for the first half of the year for carbon steel bars, billets, etc.

The National Enameling & Stamping Company, New York, is pushing construction on its new sheet mill at Granite City, Ill., and plans to have the plant ready for service early in the summer. It will be placed on the active list at the earliest possible date. The mill, with machinery, will represent an investment of about $1,500,000. The company is maintaining full capacity operations at its other mills at Baltimore, Md., and different parts of the country.

The Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., will place its new mill at Fairfield, Ala., in active service at an early date, and finishing work is now practically completed. The mill represents an investment of close to $1,000,000.

The Central Steel Company, Massillon, Ohio, has preliminary plans under consideration for the construction of a new blast furnace. A number of other plant extensions will be made, including the installation of an 8-inch mill, estimated to cost approximately $1,000,000, with machinery. R. E. Bebb is chairman of the board.

Work will be placed in progress at once on an addition to the Wisconsin Steel Works, South Chicago, Ill., owned and operated by the International Harvester Company, 606 South Michigan Avenue, Chicago. The work will consist of a blooming mill, stripper building, soaking pit department, and a number o fauxiliary structures estimated to cost approximately $500,000, with machinery.

The Reliance Coke & Furnace Company, Pittsburgh, Pa., has work under way on improvements and extensions in its Claire furnace at Sharpsville, Pa., and will install a quantity of new equipment to thoroughly modernize the mill. It is planned to have the plant ready for service at an early date.

The Dominion Alloy Steel Corporation, Sarnia, Ont., recently organized with a capital of $15,000,000, has preliminary plans in progress for the construction of a new steel works on the Indian reservation in this section. The plant will consist of a number of mills, with power house, and is estimated to cost in excess of $1,500,000. It is expected to commence work in the near future. The new company is headed by Francis P. Dawson and William A. Watson. G. A. Simpson, Hamilton, Ont., at one time connected with the Steel Company of Canada, Ltd., is interested in the new organization.

The Indianapolis Steel Products Company, New Palestine, Ind., has work in progress on a new local plant for the manufacture of steel products. It will consist of a main one-story building, 100x200 feet, estimated to cost approximately $100,000, with machinery. The equipment installation will be commenced at an early date, with facilities to provide for the employment of about 100 men. The company was recently organized and is headed by W. M. Lewis and Walter Bledsoe.

TRADE NOTES

The Gellert Engineering Company of Philadelphia has been engaged by the Colorado Fuel & Iron Company to design a single unit Cottrell electrical blast furnace gas cleaner which will be built for the Pueblo plant. The work is being done under the supervision of Wilfred Sykes, consulting engineer for the Colorado Fuel & Iron Company. The company has devised a special plan by which the Cottrell cleaning plants are considerably less expensive than before. Those plants which have been built have been giving years of satisfactory results. Due to the extension of its activities, the Gellert Engineering Company has opened an office at Pittsburgh in the Oliver Building. L. S. Kerchner and R. M. Marshall both represent the company in Pittsburgh. All sales are now handled directly by the company. Consequently all inquiries on Cottrell plants should be addressed to the company's office at Philadelphia or Pittsburgh.

In order to organize more effectively for its greatly increasing Thermit rail welding business, the Metal & Thermit Corporation has appointed Mr. Charles F. Lederer as general supervisor of rail welding, to assume entire charge of all technical work in the field. A corps of rail welding supervisors will be organized in connection with the various branches of the company so that rail welding customers will have at their command a real service department to instruct their rail welding men and assist them in every way possible. No one is better qualified than Mr. Lederer for this new position, and his long and practical experience in street railway track work has fitted him to advise not only on the welding matters, but on other phases of track construction and reconstruction. Mr. Lederer has been connected with the rail welding department of the Metal & Thermit Corporation for over two and a half years and was formerly superintendent of way of the Milwaukee Electric Railway & Light Company, Milwaukee, Wis., having served that company for a period of over 12 years in its track department.

Announcement has been made by the officials of the American Rolling Mill Company that S. R. Rectanus, who has for some time past occupied the position as director of employment and later director of the personal service division, has been advanced to the position of assistant manager of the Ashland Division at Ashland, Ky.

Mr. Frederic B. Menner, formerly works engineer and manager of Scullin Steel Company, has resigned to enter business for himself representing several well known manufacturers. His new address is Syndicate Trust Building, St. Louis, Mo.

C. L. McKinsey of the Duquesne Slag Company, Pittsburgh, has been elected president of the National Slag Association. C. E. Ireland, of the Birmingham Slag Company, Birmingham, Ala., was named vice president of the association, and H. J. Love was re-elected secretary-treasurer at the recent meeting in Cleveland.

Harry A. Arthur has been elected president of the American International Corporation, succeeding M. C. Brush, resigned. Mr. Brush will continue as chairman of directors. R. C. Shepard has been elected vice president and treasurer. Mr. Arthur, who has been senior vice president of G. Amsinck & Company for two years, also has been elected president of that company.

The Pittsburgh branch of the Metal & Thermit Corporation on May 1 will be moved from 801-807 Hillsboro Street, Corliss Station, to 1514 Fayette Street, N. S. In order to take care of the increasing business in the Pittsburgh territory, a modern welding shop is now being constructed at the new quarters and will be equipped with excellent facilities for making Thermit welding repairs and relining crucibles. A large stock of Thermit equipment and materials will be carried at all times for the convenience of customers. This new shop will enable the Pittsburgh branch with its experienced corps of representatives to give exceptionally prompt and efficient service in the Pittsburgh district. The new shop will be also equipped for making welds in lighter sections by means of the oxy-acetylene process.

The Metal & Thermit Corporation, New York, is conducting some recent extensive experiments with different types of burners to be used in connection with its standard Thermit preheaters, found that the best results were secured with a burner pipe ⅜ in. dia., swaged down at one end and then drilled with a 5/16 in. hole. Such a burner pipe fully atomizes the fuel before it enters the mold and gives the best combustion. It was found that when larger burners were used, or when ends had not been swaged down, that considerable air and fuel are wasted. The fuel does not become fully atomized, with the result that raw oil is carried into the mold or is wasted by dripping from the end of the pipe. A proper nozzle as described is so easily made that it is strongly recommended to Thermit users.

Alfred I. Phillips, formerly associate gas engineer of the National Bureau of Standards, and lately service engineer for the American Gas Association, has joined the organization of Arthur D. Little, Inc., Cambridge, Mass., as gas engineer.

George Morrisey, formerly engineer of the American Coke & Chemical Company, Chicago, has been elected chief engineer and a director of the company. Mr. Morrisey has acted in the capacity of consulting engineer of the St. Louis Coke & Chemical Company.

Clifford F. Messinger, for the past three years general sales manager of the Chain Belt Company, Milwaukee, has been elected second vice president, according to an announcement just made by the company. Mr. Messinger graduated from the Sheffield Scientific School, Yale University, in 1911.

Mr. J. L. Edwards, for the past four years district engineer for the Mahr Mfg. Company, with headquarters at Pittsburgh, Pa., has resigned to take the position of district manager of the Pittsburgh territory for F. J. Ryan & Company, industrial heating equipment specialists, Wesley Building, Philadelphia, Pa. The Ryan Company's offices will be located in the Oliver Building, Pittsburgh, and this office will have supervision over the entire territory of Western Pennsylvania, certain sections of Eastern Ohio and the northern section of West Virginia.

COMING MEETINGS

May 2-4—National Foreign Trade Council annual convention in New Orleans. O. K. Davis, 1 Hanover Square, New York, is secretary.

May 3-5—American Electrochemical Society semi-annual meeting, Hotel Commodore, New York. Colin G. Fin, 327 South LaSalle Street, Chicago, is secretary.

May 7-9—American Association of Engineers annual convention at Norfolk, Va. C. E. Drayer, 6 East Adams Street, Chicago, is secretary.

May 14-16—National Association of Manufacturers of the United States of America annual conference, Waldorf-Astoria, New York.

May 15-16—National Pipe & Supply Association convention at Cincinnati. Geo. L. McIlvane, 909 Oliver Building, Pittsburgh, is secretary.

May 15-17—American Iron, Steel and Heavy Hardware Association annual convention, Drake Hotel, Chicago. A. H. Chamberlain, Marbridge Building, New York, is secretary.

May 15-18—National Association of Purchasing Agents annual convention at Cleveland. O. H. R. Heydon, 19 Park Place, New York, is secretary.

May 17-19—National Supply and Machinery Dealers Association; Southern Supply and Machinery Dealers Association, and American Supply and Machinery Dealers Association triple convention, Cincinnati. F. D. Mitchell, 1819 Broadway, New York, is secretary.

May 25—American Iron and Steel Institute annual meeting at New York City N. Y.

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The Blast Furnace and Steel Plant

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